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The Fourth International Locust Conference, Cairo, 1936.

THE "Proceedings of the Fourth International Locust Conference, Cairo, 23rd April 1936", which has been recently published, is a handsome volume on which the Egyptian Government might well be congratulated, though one might wish that it had been issued more expeditiously. The "Proceedings" serve to remind us that the beginning of a new locust visitation, which, from past experience, might be expected in Northern India at intervals of 4 to 8 years, may not be far off, and that, as in the case of States expecting war, the best course is a policy of armed preparedness, with trained staff and control material ready to come into action at a moment's notice.

In the past, Governments took interest in the Locust Problem only while locusts were present in their millions devastating the crops, and spent vast sums of money on their control, but when they disappeared in course of time, no further interest was taken, till such time as another visitation made its appearance. The reason for this apparent neglect is not far to seek. In the case of such pests or diseases, as are confined to a particular country or tract and are of annual recurrence, it should not be difficult for that country to arrange for their study and control, but where one is concerned with a plague of the nature of locusts, capable of migrating long distances across a number of countries, and appearing, moreover, after long intervals of absence, it is research work on a basis of Inter-State or International co-operation that is called for.

Various conferences had been held in the past, with the object of achieving a common orientation of policy and mutual co-operation in combating locust visitations. The earliest, possibly, was the one held at Pretoria in 1906, composed of representatives of Basutoland, the Cape Colony, Natal, the Orange River Colony and the Transvaal, and another met at Montevideo in 1913, when delegates from the Argentine, Bolivia, Brazil, Paraguay and Uruguay conferred about the investigation of the breeding grounds of the South American locust. In October 1920, an International Conference

in connection with the organisation of locust control was held at Rome under the auspices of the International Institute of Agriculture, in which 20 States of the Old and the New Worlds participated. It resulted in the Rome Convention of 31st October 1920, whereby adjoining States bound themselves to make co-operative efforts and to give mutual help in regard to locust control.

In ancient days, and in fact till very recently, the appearance of locusts had been popularly regarded as a visitation of Divine Wrath—one which had to be endured passively, as there was no remedy for it. There were then, if at all, but vague ideas as to where locusts came from or as to why they disappeared. It was only in 1921, when Uvarov put forward his "Theory of the Phases of Locusts" that a rational explanation of the phenomena connected with locust visitations became available. He showed that when locusts were apparently no more to be seen, they had not, by any means, really disappeared. What actually happened was that they had ceased to exist in a crowded state as swarms, but were, nevertheless, present in their breeding grounds as *solitary* individuals, scattered all over the area, living just like any ordinary grasshopper. According to Uvarov, these *solitary phase* individuals can increase rapidly in numbers, under the influence of favourable environmental conditions, and subsequently form concentrations in restricted areas, where they would breed in crowded state and undergo a transformation into the *gregaria phase*, leading to the formation of incipient swarms. Observations made, under natural conditions during the past decade, by various workers, in parts of the Red Sea Coast, Mekran and West Africa, have borne out the general soundness of the hypothesis, and investigations carried out in various parts of the world under the stimulus of the phase theory have, in most cases, borne fruitful results.

Subsequent to the appearance of the severe infestations of the Desert Locust, and the African Migratory Locust and the Red Locust in various parts of Africa during the period 1927–29, and of the Desert Locust in various parts of Western Asia during 1926–29, important schemes of locust research were organised in the countries affected, of which the most prominent is the British scheme under the control of the Imperial Institute of Entomology of London, whose work is spread over Anglo-Egyptian Sudan, Arabia, and parts of Central and South Africa, and the French organization of Anti-locust Research, stationed at Alger, which carries out investigations all over the French Possessions in North Africa and French Sudan. In the Indian area, a scheme of locust research, working under the auspices of the Imperial Council of Agricultural Research, New Delhi, has been in progress since December 1930, of which the work on the Bionomics of the Locust has been carried out in the laboratories of the Punjab Government Entomologist, Lyallpur, and the field observations on *solitary phase* locusts in various breeding grounds in Sind, Baluchistan and Rajputana, by staff working under the control of the Locust Research Entomologist, stationed at Karachi. Similar research on locusts is known to be in progress in various other countries also, such as for instance, Italy, Egypt, the United States, Canada, the Argentine and the Soviet Union.

It was felt, however, that there was bound to be an unnecessary reduplication of work, as well as a great deal of overlapping, when locust research was being undertaken in different places without a knowledge of what was being done elsewhere, and in view of the need of formulating a concerted scheme of research after pooling all the information available, the first International Locust Conference was convened at Rome by the International Institute of Agriculture under the patronage of the Italian Government in September 1931. In July 1932, the second Conference met at Paris at the invitation of the French Government, the third one at London in September 1934, under the patronage of the British Government, and the fourth at Cairo under that of the Egyptian Government in April 1936. We understand that the Fifth International Locust Conference will shortly meet at Brussels at the invitation of the Belgian Government at the end of August, during the current year.

There is little doubt that international meetings of this character are of great service in focussing together a knowledge of the work that is being carried out at various different centres. Usually, much of the work in progress at a particular centre, would tend to remain unpublished, awaiting a definite confirmation of results, so that for a considerable time workers would

remain in entire ignorance of the results obtained elsewhere. Much of the time and energy of workers could, therefore, be conserved, if facilities of contact between workers in the different parts of the world could be periodically provided. Of greater value than even the regular discussion of subjects at the plenary sessions of the Conference, are the opportunities provided of informal contact between workers and of mutual exchange of experiences on various details, which would not emerge in the course of formal meetings.

A cursory glance at the resolutions passed at the Conference and the recommendations made in regard to the international plans of future work on various locusts would give one an idea of the vast ground covered. The following formed the subjects of some of the resolutions: statistics of damage by locusts and grasshoppers, study of the phases, study of migrations in correlation with meteorological conditions, studies of the breeding grounds, factors controlling locust activity, the ecological control of outbreak centres, methods of forecasting locust outbreaks, locust control methods including employment of aeroplanes, and study of natural enemies. The resolutions recorded are highly valuable, as they embody the latest information available on the particular subject. Most of the papers submitted to the Conference have been appended to the "Proceedings" and are of exceeding value as records of experiences in different countries under varying climatic conditions.

Among the documents included in the "Proceedings," are four papers submitted by the Indian delegation, which call for a few comments. Two of the papers were contributed by Khan Bahadur Afzal Husain, who attended the Conference as the delegate representing India. Besides other interesting results, two of the conclusions recorded in his papers are of outstanding merit, *viz.*, the effect of (1) *carbon dioxide*, and (2) *continued physical exertions on the part of the hoppers* on the development of black pigments on the body. In this connection, it may be stated that the possession of black pigment by the hoppers is one of the main points of difference between the *solitaria* (usually green) and the *gregaria* (always black) hoppers, and it is well known that green hoppers, if kept crowded in a cage, will assume the black colouration. Mr. Husain's experiments have shown that *even when bred singly*, a hopper would develop black pigment if reared in an atmosphere of a certain proportion of carbon dioxide, and secondly, also if the hopper is kept continuously active by the use of certain artificial contrivances. The other two papers by Y. Ramachandra Rao were the outcome of continuous observations recorded by the survey staff stationed at various places in the Sind-Rajputana desert areas and in the Lasbela-Mekran coastal areas during a series of years. One of the papers deals with the evidence obtained in regard to the existence of powers of long distance migrations among the *solitary phase* population of the Desert Locust, whereby the *solitaria* individuals are shown to be able to breed in two different rain-belts, just like the swarms of the *gregaria* phase. The evidence as to the ability of the solitaries to migrate rather upsets the usually accepted conception of solitary phase populations, which are generally supposed to be sedentary and static, the migratory power being developed only when the swarms are produced. On the other hand, the ability, on the part of the solitary phase, of taking advantage of favourable conditions of breeding in two different rain-belts in the same year, greatly increases its powers of multiplication and consequently, the danger of its swarming. The second paper describes the outbreak centres that were discovered in the interior valleys of Mekran in 1935. These had been formed as a result of concentrated egg-laying in the valleys by solitary locusts that had migrated there from the coastal areas, and are of great importance to India, as forming the foci from which locust infestations might develop under favourable conditions.

One of the important results of the various schemes of locust research has been the tracing of many of the infestations of recent times to their actual outbreak centres. In the case of the Desert Locust, it was found that infestation had originated in three different centres: (1) in the Mekran area of British and Iranian Baluchistan, (2) in the Red Sea Coasts of Sudan and Arabia and (3) in some centre in the western areas of Sahara. As regards the African Migratory Locust, the infestation was proved to have begun first in the region of the Niger Bend in French Sudan, and to have gradually increased in extent and intensity till an

enormous extent of area of over 10 million square miles of territory on the African Continent was covered. The determination that this extensive infestation of the Migratory Locust had originated in a single outbreak centre, *viz.*, the San-Macina District of French Sudan has been appropriately described as "an outstanding achievement of the international anti-locust investigations".

Adverting to the practical aspect of the results of locust research, it may be stated that it is an exceedingly difficult task attempting to control locusts, when they have taken the shape of swarms. The swarms appear in such large numbers and have such immense powers of migration, that it would be well nigh impossible to control them. On the other hand, it should be an easier task to tackle an infestation in its initial stages, in the outbreak areas. If all potential outbreak centres could be delimited, and the area watched by a fully competent organisation, the incipient swarms could be dealt with as they arise. If this could be arranged, it should be possible to nip the evil in the bud, and save the enormous expenses entailed in the attempt to deal with infestations after they have developed.

In the words of Uvarov, "the alternative to thorough studies of locusts leading to rational schemes of control, is to continue paying annual tribute to the oldest enemy of agriculture—the Locust. This may have been unavoidable in the past, but there is now no excuse for carrying on the old policy of letting locusts develop unchecked and then spending millions in attempting to control them."

Forest Research in India, 1936-37.*

TWO official publications summarising the work done during 1936–37 at the Forest Research Institute, Dehra Dun and in the various British Indian Provinces (including Burma) have recently been issued. The first opens with a general review followed by five chapters, each dealing in turn with the work of the Sylvicultural, Botanical, Entomological, Utilisation and Chemical sections of the Institute. The second has much the same general plan, the sectional accounts, however, being summarised with reference to the provinces. This arrangement, while admitting of reference under subject-heads, precludes a coherent account being given of the work done on Forest Research in any one province. The compiler of the Reports has realised this drawback and sought to overcome it by brief provincial summaries in the opening "General" chapter in the second publication.

It is not possible even to merely mention, in a brief note the important problems, work on which is referred to in these two interseting reports. It would be very much like summerising a catalogue. The range of problems covered is exceptionally wide and, to the student who is particularly interested in any of these, an appendix to each of these reports provides a useful bibliography of the publications.

Special mention must be made of two features, during the year under review, which are of significant importance to Forest Research in India. The first of these is the inauguration of the Timber Development Section at the Dehra Dun Institute. Secondly, this was the first year in which the Indian Paper Mills subscribed towards part of the cost of the Paper Pulp Section of the Institute. This donation is, perhaps, the first outward indication that at long last Indian industry is beginning to realise the importance of Indian forests as feeders of Indian industry. Such recognition, long overdue and in an increasing measure in future, is essential for the porsperity of Indian industry no less than of Indian forests.

The reports are printed on paper made at the Dehra Dun experimental paper plant and this fact finds mention (as suggested in an earlier review in *Curr. Sci.*, Vol. IV, 789) at the beginning of each volume. A few well-chosen photographs in the body of the reports, while adding to their value, would go far in counteracting the "Blue Book" atmosphere of these publications.

EMMENNAR.

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* *Forest Research in India*, 1936-37. Part I. Forest Research Institute. (Manager of Publications, Delhi), 1937. Pp. 92. Price Rs. 1-10-0 or 2*sh.* 9*d.*

Forest Research in India, 1936–37. Part II. Provincial Reports. (Manager of Publications, Delhi), 1938. Pp. 205. Price Rs. 4-6-0 or 7*sh.* 3*d.*

Production and Measurement of Low Temperatures.

By K. R. Dixit.

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THIRTY years ago Prof. Kamerlingh Onnes, working in Leiden, with the help of Dr. W. H. Keesom and Mr. H. Filippo succeeded in liquefying helium for the first time on July 10, 1908. He[1] has given a graphic description of his experiments, and we shall quote here only a small part of it.

"The surface of the liquid was soon made clearly visible by reflection of light from below, and that unmistakably because it was clearly pierced by two wires of the thermo-element. This was at 7–30 p.m. when the surface had once been seen, it was no more lost sight of. It stood out sharply defined like the edge of a knife against the glass wall."

This article is written to commemorate the production of 'liquid helium', and gives the present position in the low temperature technique.

Introduction.[2, 3]

It was Lavoisir, who suggested that if the earth were cooled sufficiently, even the gaseous air above it might take a liquid form. Sir Humphry Davy and his young assistant Faraday found that the gas chlorine could be condensed to a yellow liquid. Ammonia, sulphuretted hydrogen and hydrochloric acid gas also quickly yielded to their experimental skill. By 1823 Faraday had installed at the Royal Institution a liquefaction plant. Solid carbon dioxide was introduced in 1834 by Thilorier. Faraday was quick to turn to advantage the new discoveries; by mixing carbon dioxide snow with ether he obtained a freezing mixture, capable of cooling to −110° C.

Thomas Andrews, the Professor of Chemistry at Belfast, tried to liquefy air, and like the others before him failed, and yet made of his very failure a success. In a Bakerian lecture before the Royal Society he explained that unless the pressure exceeds a certain 'critical pressure' and the temperature is below a certain 'critical temperature' peculiar to the gas we can never hope to liquefy it; cold allied with compression succeeds where one alone fails.

The story then is one of triumph after triumph. Oxygen was liquefied by Olszewski in 1883, and two years later nitrogen and carbon monoxide. The list of lowest temperatures as they were reached, reads like the records of athletic achievements; in both the next step is always harder to achieve than the one before. A new principle was applied to produce the cooling. If a gas under pressure, below the inversion temperature, is allowed to expand freely through a fine nozzle or if it is allowed to do mechanical work while expanding, it will cool, and may reach a temperature at which it liquefies. Thus we get two methods for liquefying the gases. One employs the Joule-Thomson effect, which allows the gas to expand suddenly and so produce the necessary cooling by the performance of internal work; the Linde and Hampson processes depend upon this principle. The other processes employ the reversible expansion of the gas with the performance of external work; the Claude and Heylandt processes are of this nature. In all these processes the regenerative method is used, the oncoming gas being cooled by that which has already passed through and been reduced in temperature, thus the oncoming gas on expansion reaches a still lower temperature until at last the liquid is produced. By such means, hydrogen was liquefied by Olszewski[2a] in 1892. Hydrogen is a liquid at − 253° C. and it solidifies at − 259° C. Helium was liquefied by Kamerlingh Onnes for the first time in 1908. It is a long way from Michael Faraday's comparatively simple experiments to the operation of a modern liquid helium plant. By reducing the pressure over liquid helium, still lower temperatures can be reached; and it was in this way that Keesom succeeded in 1933 in cooling liquid helium to an estimated temperature of about 0·71° K. Liquid helium at present is available for research in such centres as Berkeley, Berlin, Breslau, California, Cambridge, Kharkow, Leiden, Oxford, Toronto and Washington.

Still lower temperatures can be obtained by the method of adiabatic demagnetisation of a paramagnetic salt, due to Debye[4] and Giauque.[5] The technique of this method has been developed by Giauque[6–9] in California; de Haas[10–14] in Leiden, and by Kürti and Simon[15–18] at Oxford. The method consists in magnetising the

substance in a strong magnetic field and removing the heat so generated by cooling in liquid helium and then thermally isolating it. The magnetising field is then suddenly removed or reduced and the consequent demagnetisation results in further cooling. Using this method de Haas[19] succeeded in obtaining a temperature of 0·005° K.

It is possible by means of observations and an application of gas laws to determine the equation of state for helium, that enables us to establish a temperature scale applicable over a range extending down to about 1·5° K. Below this temperature we are largely dependent on extrapolation. The vapour pressure of liquid helium enables us to reach the temperture 0·71° K; and the magnetic susceptibilities of certain salts can be used to tell us when such temperatures as 0·05° K are reached.

Thermodynamics applied to the Liquefaction of Gases.[20–22]

It will be possible for us to liquefy a gas if and only if, we apply a pressure p to the gas which is greater than the critical pressure p_c, at a temperature T which is less than the critical temperature T_c. The critical temperature and the critical pressure is a property of the gas; and their numerical values can be calculated for any gas, if the equation of state for that gas is known. Thus assuming that van der Waals' equation

$$\left(p + \frac{a}{v^2}\right)(v - b) = RT \quad .. \quad .. \quad (1)$$

is applicable to the gas, we get the critical temperature

$$T_c = \frac{8}{27} \cdot \frac{a}{bR}$$

and the critical pressure

$$p_c = \frac{1}{27} \cdot \frac{a}{b^2}.$$

The following six processes are used in producing cooling and low temperatures.

(1) The solution of salts, acids or gases in water or ice.

(2) Evaporation.

(3) Adiabatic expansion of a gas with the performance of external work.

(4) Throttling of a gas and taking advantage of the Joule-Thomson effect.

(5) Using the heat of adsorption.

(6) Adiabatic demagnetisation.

(1) *Freezing Mixtures.*—If some salts or acids (whose heat of solution is negative or is less than the amount of heat required to melt the ice mixed with them) are mixed with ice we get freezing mixtures. Table I gives a list of the freezing mixtures commonly employed.

Table I.

Quantity of salt per 100 grms. of ice	Approx. temperature of the mixture
10 grms. K_2SO_4	− 1·9° C.
30 ,, KCl	− 10·6° C.
25 ,, NH_4Cl	− 15·0° C.
33 ,, NaCl	− 21·2° C.
200 ,, $CaCl_2$	− 35·0° C.

(2) *Evaporation.*—Latent heat is the amount of heat, we have to supply to a liquid, if the liquid is to be converted into vapour. If the liquid is thermally isolated and allowed to evaporate, the requisite heat for evaporation will be supplied by the liquid itself, and its temperature will be reduced. The space above the liquid will contain a definite amount of the liquid vapour, depending on the vapour pressure of the liquid. If the liquid vapour is carried away by a continuous stream of air,—as is done in the dew point experiment—the partial pressure of the vapour is reduced, more liquid evaporates and the temperature of the liquid is reduced. In certain experiments, the liquid is placed in a vacuum Dewar-flask, and the liquid vapour is continually pumped away, resulting again in the cooling of the liquid. This method is used with liquid helium to obtain still lower temperatures.

(3) *Adiabatic Expansion of a Gas.*—If a gas of mass M, and specific volume v, changes the pressure from p_1 to p_0 (where $p_1 > p_0$) then the external work done is given by $M\int_1^0 p\,dv$; as the expansion is adiabatic the amount of energy of the gas is reduced by $M\int_1^0 p\,dv$. Let u be the energy per unit mass of the gas, then

$$p\,dv = -du = -\left(\frac{\partial u}{\partial T}\right)_v dT - \left(\frac{\partial u}{\partial v}\right)_T dv \quad .. \quad (2)$$

but $(\partial u/\partial T)_v = C_v$ the specific heat at constant volume, and the second law of thermodynamics gives the relation

$$\left(\frac{\partial u}{\partial v}\right)_T = T\left(\frac{p}{\partial T}\right)_v - p \quad .. \quad .. (3)$$

$$\therefore \quad dT = -\frac{T\left(\frac{\partial p}{\partial T}\right)_v}{C_v} dv \quad .. \quad .. (4)$$

In the case of a perfect gas this reduces to

$$dT = -T\frac{C_p - C_v}{C_v}\frac{dv}{v} = -T(\gamma - 1)\frac{dv}{v}$$

$$\text{or} \quad \frac{T_0}{T_1} = \left(\frac{v_1}{v_0}\right)^{\gamma-1} \quad .. \quad .. \quad .. (5)$$

This method was first used by Cailletet,[23] to liquefy air, hydrogen, etc. This theory forms the basis of the Claude and Heylandt method of liquefying air.

(4) *The Joule-Thomson Effect.*—The Joule-Thomson effect is the change of temperature produced in a current of gas, when it expands adiabatically, through a porous plug. The effect of the porous plug is to keep the kinetic energy of the gaseous atoms unaltered. Let u be the internal energy, v the volume per gram and i the total amount of heat in the gas. Then

$$du + d(pv) = 0$$
$$i = u + pv = \text{constant}$$

and

$$dS = \frac{du + pdv}{T}; \quad dS = \frac{C_p}{T}dT - \left(\frac{\partial v}{\partial T}\right)_p dp.$$

Eliminating du we get

$$\left(\frac{\partial T}{\partial p}\right)_i = \left[T\left(\frac{\partial v}{\partial T}\right)_p - v\right]\frac{1}{C_p}$$
$$= \frac{T^2}{C_p}\frac{\partial}{\partial T}\left(\frac{v}{T}\right)_p \quad .. (6)$$

where S is the entropy, C_p is the specific heat at constant pressure, and the suffix i indicates that i remains constant even when the pressure changes. Equation (6) gives the change of temperature produced by the passage through the porous plug and is called the 'Differential' Joule-Thomson effect. If we change the pressure from p_2 to p_1, keeping i constant, and integrate 6 over this range, we get the 'Integral' Joule-Thomson effect ΔT_i.

$$\Delta T_i = \int_{p_1}^{p_2} \frac{T^2}{C_p}\frac{\partial}{\partial T}\left(\frac{v}{T}\right)_p dp_i \quad .. (7)$$

It is the integral Joule-Thomson effect which can be experimentally observed. The differential Joule-Thomson effect can be calculated from the observed integral effect if the rate of variation of the integral effect with respect to pressure and temperature is known. For a given pressure, we have a given temperature, the so-called inversion temperature, at which the Joule-Thomson effect changes its sign. Thus the Joule-Thomson effect tells us that if a gas is allowed to expand, under suitable conditions, it can perform internal work and produce the necessary cooling. Joule-Thomson effect was used by Linde and Hampson to liquefy air; it was also used by Kamerlingh Onnes to liquefy helium.

(5) *Adsorption and Desorption.*[24–27].—In Simon's process of liquefying helium, helium is allowed to come in contact with an adsorbing substance, kept at the temperature of liquid hydrogen. The adsorbing substance is either charcoal or chabasit (a calcium-aluminium silicate, hydrate). The heat of adsorption of helium is carried away by the liquid hydrogen bath. The system is now thermally isolated, and the adsorbed helium is made to leave the adsorbing material by pumping out the system. This results in a desorption—a negative heat of adsorption, and the system is cooled to a temperature which is below the critical temperature of helium. The expansion of the gas now results in liquefaction.

(6) *Adiabatic Demagnetisation*[28–30].—Weiss and Piccard[31] found that nickel is cooled, when quickly demagnetised in the neighbourhood of the Curie point. Debye[4] and Giauque[5] suggested that if gadolinium sulphate, which is at the temperature of liquid helium, is demagnetised adiabatically, it may be possible to obtain temperatures below 1° K.

Debye and Giauque calculated and predicted the effect for gadolinium sulphate. Their calculation was based on the following considerations: a magnetisable body contains a great number of small elementary magnets. When such a body is magnetised these magnets are directed in the direction of the field. The part of the entropy belonging to this order is decreased and the process being supposed isentropic, the part of the entropy connected with the statistical movement must necessarily increase. When, on the contrary, the disorder of the elementary magnets is increased by demagnetisation, the part of the entropy connected with magnetisation is increased and the

part belonging to the statistical movement is decreased, so that the body is cooled down.

If we wish to obtain easily seen results the following points require special attention :

(1) the elementary magnets shall not exert a directing influence upon each other (the substance used should not be ferromagnetic) ; (2) the elementary magnet shall have a moment as large as possible, subject to the restriction 1 ; (3) at low temperatures the effect will be greatest, as here the part of the entropy belonging to the magnetisation becomes comparable with the other part, while at the same time the order strongly increases.

During the adiabatic demagnetisation the entropy S remains constant, further as the substance is kept in vacuum the pressure p is also constant. The entropy S is thus a function of the temperature T, and the magnetising field H.

$$dS = 0 = \left(\frac{\partial S}{\partial H}\right)_{p,T} dH + \left(\frac{\partial S}{\partial T}\right)_{p,H} dT \quad .. \quad (8)$$

$$\text{or} \qquad dT = -\frac{\left(\frac{\partial S}{\partial H}\right)_{p,T}}{\left(\frac{\partial S}{\partial T}\right)_{p,H}} dH \quad .. \quad .. \quad (9)$$

But since the process is reversible, we can write $dS = dQ/T$, where dQ is the quantity of heat added to the substance.

$$dQ = dU + pdV + HV\chi dH$$

U is the internal energy, V the mol. volume, and χ the susceptibility of the material per cm.[3]

Writing $J = U + pV$ we get

$$dS = \frac{dQ}{T} = \frac{dJ - Vdp + HV\chi dH}{T} \quad .. \quad (10)$$

and hence

$$\left(\frac{\partial S}{\partial T}\right)_{p,H} = \frac{1}{T}\left(\frac{\partial J}{\partial T}\right)_{p,H} = \frac{C_{p,H}}{T} \quad .. \quad (11)$$

$$\left(\frac{\partial S}{\partial H}\right)_{p,T} = \frac{1}{T}\left\{\left(\frac{\partial J}{\partial H}\right)_{p,T} + HV\chi\right\} \quad .. \quad (12)$$

This means that C_p the specific heat pro mol is also a function of H. As dS is a perfect differential,

$$\frac{\partial^2 S}{\partial T \partial H} = \frac{\partial^2 S}{\partial H \partial T}, \text{ and we get}$$

$$\left(\frac{\partial J}{\partial H}\right)_{p,T} + HV\chi = TH\left[\frac{\partial}{\partial T}(V\chi)\right]_{p,H} \quad .. \quad (13)$$

$$\text{and} \quad \left(\frac{\partial S}{\partial H}\right)_{p,T} = H\left[\frac{\partial}{\partial T}(V\chi)\right]_{p,H} \quad .. \quad (14)$$

This leads to

$$dT = -\frac{TH\left[\frac{\partial}{\partial T}(V\chi)\right]_{p,H}}{C_{p,H}} dH \quad .. \quad (15)$$

Thus to make dT as large as possible $\frac{\partial}{\partial T}(V\chi)$, must be as large as possible, and $C_{p,H}$ as small as possible. Giauque found that in the case of gadolinium sulphate, although C_p obeys the Debye's T^3 law upto fairly low temperatures[32] ; yet at still lower temperatures C_p increases rapidly[6,7] ; and therefore gadolinium sulphate is not the most suitable substance for the magneto-calorific effect.

The substances which obey the law of Curie and Langevin, $\chi = c/T$, even at the lowest temperatures, are more suitable for the magneto-calorific effect. In such substances the magnetic atoms are widely separated from one another so that their mutual interaction is very small.

The Technique of the Liquefaction of Gases.

The low temperatures may be divided into five different groups :

(1) The region of refrigeration and cold storage, upto about − 50° C. using NH_3, SO_2, etc.

(2) The region of solid CO_2, and of solid CO_2 mixed with acetone, and other substances to form freezing mixtures.

(3) The region of liquid air upto − 200° C.

(4) The region of liquid hydrogen (− 252° C.) and liquid helium (− 269° C.).

(5) The region of Debye and Giauque of isothermal magnetisation and adiabatic demagnetisation.

In this article we shall describe only 3, 4 and 5. For a description of the methods 1 and 2, please refer to articles like the ' Kältetechnik ' by Meissner.[33]

The Liquefaction of Air.[20-22]

Cailletet[23] was the first to liquefy nitrogen, oxygen, air and hydrogen. He allowed them to expand suddenly from a pressure of 200 to 300 atmospheres. The presence of the liquid was manifested in the form of small drops or spray. In practice, however, it is always necessary to use multiple expansion as well as previous cooling.

Carl von Linde[24] was able to produce liquid air for the first time on a commercial scale. He used the heat exchangers where

the gas cooled by expansion was made to cool the incoming gas, he also made use of the Joule-Thomson effect to produce the cooling.

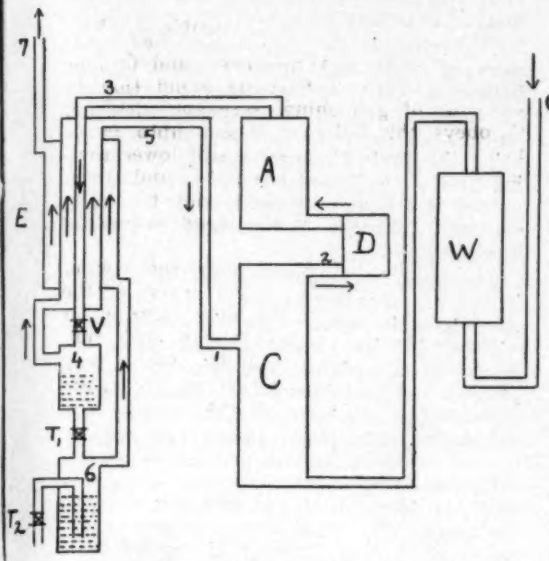

Fig. 1.

Scheme of Linde's liquid air plant.

Linde's Liquid Air-Plant.—The air is sucked in at 0 at atmospheric pressure. It is then purified in W, *i.e.*, the dust particles and carbon dioxide are removed. The purified air goes into the compressor C, where it is compressed to 200 atmospheres. Then it goes through 2, the drying tube D, and the chamber A, which is surrounded by an ammonia freezing mixture, where the compressed air is cooled to − 50 °C. This cooled, compressed air enters the heat exchanger E through the tube 3. After that it passes through the valve V, which reduces the pressure to 20–50 atmospheres. A large portion of the air which is thus allowed to expand goes back to the compressor through 4, 5 and 1 ; while a small part of it is liquefied and is allowed to fall in 6 through the tap T_1. The liquefied air from 6 can be removed by the tap T_2, while the air above the liquid air, is allowed to pass through the exchanger, and escapes into the atmosphere at 7. Thus after the machine has started, only just sufficient quantity of air to replace the liquefied air will be sucked up in the machine.

Claude[35] *and Heylandt Liquid Air-Plant.*—Purified air is admitted through 0 into the compressor C, and is compressed to 200 atmospheres. Then it goes through 1 and the drying tube D. At 2 the current of air branches itself, a part of it going through 4 into an engine A, where it performs external work, is expanded to one atmosphere and is cooled ; this cooled air goes through 5 into the heat exchanger E_1. The other branch of the current goes through the exchanger E_1 and is cooled ; then it goes through the valve V and expands to 1 atmosphere. Thus a part of the air that escapes through the valve V is liquefied. The not liquefied air goes through the exchanger E_2 and escapes into the atmosphere at 7.

Thus Heylandt has substituted for the ammonia freezing mixture of Linde, a cold current of air, which is cooled by allowing it to do some external work. The efficiency of the machine appears to be 25%, *i.e.*, 25% of the air compressed in the compressor will be liquefied.

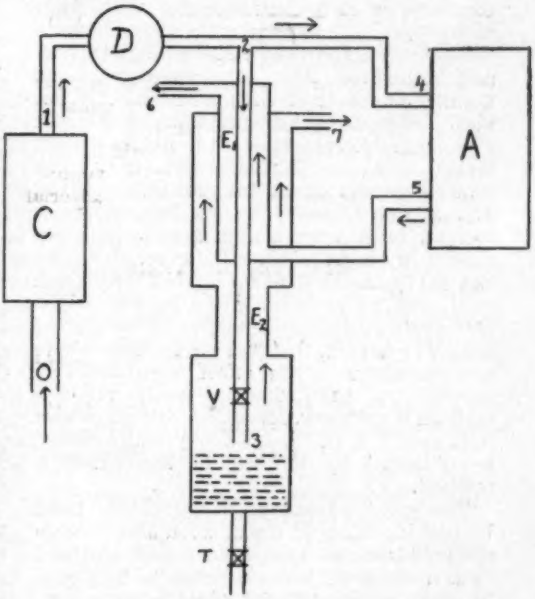

Fig. 2.

Diagram of the Claude and Heylandt liquid air machine.

Liquefaction of Hydrogen and Helium.

At present two principal methods are used for cooling and liquefying gases. The first method is based on cooling produced by adiabatic expansion where the expanding gas is cooled by doing external work. Olszewski[36] applied this method to the liquefaction of hydrogen. This method has also been used by Simon for liquefying helium[37] and hydrogen.[38] This method can however be only conveniently applied for obtaining small amounts of liquid hydrogen and helium. Further the method is also complicated by the fact that high pressures are required, and that pre-cooling either with liquid nitrogen or hydrogen boiling at reduced pressure is necessary.

The alternative method of cooling, which was the only method used for the production of liquid hydrogen and helium on a large scale till 1934, consists in allowing the gas which is to be liquefied to expand and do internal work. The phenomena is known as the Joule-Thomson effect and was first employed by Dewar[39,40] to produce liquid hydrogen. But there is always the danger of explosion when we are working with large quantities of hydrogen. And Dewar's method was improved by Kamerlingh Onnes[41] and Lilienfeld who introduced a large number of safety devices. Meissner[42,43] has also designed a hydrogen liquefier for the Physikalisch-Technische Reichsanstalt, which works on the same principle. The Joule-Thomson effect was also employed by Kamerlingh Onnes[1,44] for the liquefaction of helium. But since helium approaches very closely to the requirements for an ideal gas, the Joule-Thomson effect is very small, and it is only by pre-cooling the helium to the temperature of liquid hydrogen boiling at reduced pressure, that we reach a stage where the magnitude of the effect is sufficient to liquefy the gas. The efficiency of this method is very low. Meissner[45] estimates that it is only 1% of the efficiency which would be obtained by the use of the adiabatic method.

The great advantage of liquefying gases by making them do direct work on a mechanical system has long been recognised, and this method is now commonly employed for the liquefaction of most gases. Due, however, to the technical difficulty of constructing an expansion engine, which will operate at very low temperatures, this method could not be easily applied to helium and hydrogen. Kapitza[46] succeeded in developing an expansion engine which will work continuously at low temperature, and was able to use the more efficient method to liquefy helium.

The liquefier is pre-cooled by liquid nitrogen only, and further cooling of the helium is done in two stages; down to 10° K by means of the expansion engine, and finally down to liquefaction point by using the Joule-Thomson effect. The starting time of the liquefier is 1¼ hours, and the output is 2 litres per hour, using 1⅓ litres, of liquid nitrogen to produce 1 litre of liquid helium.

The most important part of the liquefier is the reciprocating engine. The piston of the engine is loosely fitted in the cylinder with a definite clearance, and when the gas is introduced into the cylinder at high pressure, it is allowed to escape freely through the gap between the cylinder and the piston. The piston moves very rapidly on the expanding stroke and the expansion takes place in a fraction of a second, so that the amount of gas escaping through the gap is very small, and does not appreciably affect the efficiency of the machine, which is about 60%. The expansion engine works at the rate of 100 to 120 strokes per minute and treats about 30 cubic metres of helium at N.T.P. per hour. The diameter of the piston is 31 mm. and the stroke between 35 and 50 mm. The inlet and the outlet pressures are 30 and 2·2 atmospheres respectively, while the inlet temperature of the gas is 19° K and the exhaust temperature is 10° K. The mechanism which allows the piston to move quickly on the expanding stroke and do work, and then move slowly, back again, is a hydraulic mechanism. The piston is made of Firth's 'Staybrite' steel and the cylinder of phospher-bronze.

This liquefier of Kapitza represents a very notable advance in the design of apparatus for the production of liquid hydrogen and liquid helium.

It is possible to obtain still lower temperatures, by allowing liquid helium to boil under reduced pressure. Kamerlingh Onnes used a series of diffusion pumps and obtained in 1921 a temperature of 0·85° K. Keesom[47] used two Gaede-pumps with a capacity of 670 litres/second, and reached the temperature of 0·71° K in 1933. Table II gives the

temperature and the corresponding vapour pressure of helium.

TABLE II.

Vapour Pressure of Liquid Helium.[48]

Temperature on the Kelvin scale	Pressure in mm. of mercury
4·219	760·0
1·714	10·0
1·237	1·0
1·00	$1{\cdot}5 \times 10^{-1}$
0·50	$2{\cdot}5 \times 10^{-5}$
0·30	7×10^{-10}
0·10	3×10^{-31}
0·03	6×10^{-103}

In this connection it may be pointed out that the temperature of a body in the interstellar space cannot fall below 2 or 3° K as it always has to be in equilibrium with steller radiation. Further the vacuum in the intersteller space is of about 10^{-22} cm. Hg. Thus in the direction of low temperature and low density we can surpass the conditions found in nature.

THE METHOD OF ADIABATIC DEMAGNETISATION.

To obtain much lower temperatures than 0·71° K, the method of adiabatic demagnetisation of paramagnetic salts, with the initial temperatures sufficiently low, suggested by Debye and Giauque is used. This method is based on the possibility of diminishing considerably the entropy of some paramagnetic salts by isothermal magnetisation. The subsequent demagnetisation, if carried out adiabatically, then results in a lowering of the temperature. A suitable substance for this method will be one with magnetic dipoles which are relatively free, *i.e.*, one in which the possible orientations of the dipoles all have nearly the same energy. In this case an external magnetic field will be able to produce a big change in the order of the dipoles, thus diminishing the entropy. Such a substance can be recognised by the fact that it follows the Curie-Langevin law very closely, since this law is derived on the assumption of perfectly free elementary magnets. A substance possessing perfectly free dipoles, and therefore following the Curie-Langevin law at all temperatures cannot exist, because for such a substance $S_{T=0^\circ K} \neq 0$, and this, that is, the entropy not vanishing at absolute zero is contradictory to the Nernst's law. To measure these low temperatures we establish a thermodynamic scale of temperature ; we shall consider this scale in the next section.

Now we shall give the results of the experiments performed by various people. Here T_i and H_i are the initial temperatures and intial magnetic fields ; while T_f and H_f are the final temperatures and the fields ; when the value of H_f is not specially mentioned it is nearly zero or negligible. The thermodynamical considerations tell us that

$$T_f = \text{constant } \frac{T_i}{H_i}.$$

Kürti and Simon[17] used five different substances and the results they obtained are given in Table III.

TABLE III.

Substance	T_i° K	H_i in gauss	T_f° K
$FeNH_4(SO_4)_2, 12H_2O$ ironammonium alum	1·23	14,100	0·038
	1·23	2,900	0·187
	2·23	10,300	0·099
$MnSO_4(NH_4)_2SO_4 6H_2O$ ..	1·23	8,000	0·09
$\frac{1}{2}Gd_2(SO_4)_3, 8H_2O$ ..	1·15	5,400	0·35
$KCr(SO_4)_2, 12H_2O$ ..	1·16	24,600	0·031
1[$MnSO_4(NH_4)_2SO_4.6H_2O$]+ 20 [$MgSO_4(NH_4)_2SO_4.6H_2O$]	?	?	0·05 to 0·08

Giauque and McDougall[8] start with 50 grms. of gadolinium sulphate and a field of 8000 gauss ; if the starting temperatures are 3·4, 2·0 and 1·5° K the final temperatures are 0·53, 0·34 and 0·25° K respectively.

de Haas[13,14] and others, using only a few hundred milligrams of the substance obtained the results given in Table IV.

ON THE POSSIBILITY OF OBTAINING STILL LOWER TEMPERATURES.[49,50]

Heat motion consists in the unordered motion of the smallest particles. The intensity of this irregular motion rises with increasing temperature. There is no upper limit to the intensity of this motion, and

TABLE IV.

Substance	H_i in gauss	H_f	T_i° K	T_f
CeF_3	27,600	4,500	1·314	0·27
CeF_3	„	2,200	„	0·19
CeF_3	„	850	„	0·13
Ds $(C_2H_5SO_4)_3$, $9H_2O$	19,500	200	„	0·12
Ce $(C_2H_5SO_4)_3$, $9H_2O$	27,600	850	„	0·09
$K_2SO_4Cr_2(SO_4)_3$, $24H_2O$	19,500	350	„	0·05
$Cs_2SO_4Ti_2(SO_4)_3$, $24H_2O$	25,075	1·0	„	0·0055
1 $[K_2SO_4Cr_2(SO_4)_3, 24H_2O]$ + 14·4 $[K_2SO_4Al_2(SO_4)_3, 24H_2O]$ ..	24,075	„	1·92	0·0044

thus there can be no limit to the high temperatures. But there will be a lower limit to the temperature scale, at the point where the thermal motion stops altogether. This point is called the absolute zero, and although it is impossible to reach it, its position is given with great accuracy as $-273{\cdot}1°$ C. Nernst's theorem postulates that at absolute zero all substances are in a state of perfect order, which means that it will be impossible to reach the absolute zero of temperature. This, however, does not mean that it will be impossible to reach any finite temperature, be it as small as you like.

To heat a substance means to increase its energy, but still more to increase the internal disorder of its particles. To cool a substance means to diminish its energy, and to increase the internal order of its particles. A gas will liquefy if it is cooled sufficiently and will solidify if it is cooled still further. The solidified gas is a system which is in a state of nearly perfect order. The thermal vibrations of the atoms about their mean positions, are the source of some disorder. On cooling still further this disorder tends to vanish and at these temperatures the disorder, if any, is likely to be due to the interaction forces between the nuclear moments and their surroundings.

Thus if we start with the room temperature and go to lower and lower temperatures, we observe that the gaseous disorder is the first to vanish. This happens when we reach a temperature at which there are no more gases available. The crystalline disorder due to the forces between the atoms is the next to pass over into a state of order. The only disorder available at this stage appears to be due to the interaction between the nuclear moments and their surroundings. And the method which suggests itself is to try to work with a substance that exhibits nuclear paramagnetism.

The part played by the nuclear paramagnetism in producing still lower temperatures, can be better understood if we consider the time effects in the magnetic cooling method.[50] Suppose we have a paramagnetic salt, the ions of which carry a magnetic moment μ. We assume that the interaction of these spins with the lattice and with one another is small, so that the spins can be considered as relatively free, but not completely free. These properties are realised in salts of those ions of the iron group or the rare earths which have a multiple S-state as the ground state. In the absence of a magnetic field the spins are distributed at random. If now we switch on a magnetic field isothermally, the spins will be orientated in the direction of the field. The entropy will decrease, which means that the heat of magnetisation must be conducted away or that the magnetic energy $2H\mu$ of the spins must be transferred to the lattice vibrations. According to Heitler, in the case of paramagnetic salts normally employed, the time required for the transfer of this energy is short enough for temperatures above about $0{\cdot}1 - 0{\cdot}2°$ K

and magnetic fields higher than about 1500 gauss, but rather long for lower temperatures and lower magnetic fields.

Now we shall discuss the question whether the use of the nuclear spins offers any hope of attaining still lower temperatures.

Consider first the case of a diamagnetic insulating crystal the nuclei of which carry a magnetic moment μ_n. μ_n is about one thousandth that for an electron. This gives rise to a very small interaction between the crystalline field and the nuclei. And as a result the time required for the exchange of energy in the present case is at least 10^{12} times the time of exchange for electrons. This time is of the order of magnitude of 10^6 years. Thus we cannot expect that the use of nuclear spins will lead to any further progress in approaching the absolute zero, if we start with a diamagnetic insulating crystal.

The nuclear spins of the metals, however, present an entirely different case. Here the magnetic energy $2H\mu_n$ can also be transferred to the conduction electrons, and the time required for an exchange of energy between the nuclear spins and the conduction electrons is about one second; this time is short enough to allow a further application of the magnetic cooling method.

Measurement of Low Temperatures.

The conception of absolute temperature is based upon the properties of an ideal gas. This conception was first introduced by Lord Kelvin, and temperatures measured from the absolute zero of temperature are said to be measured on the Kelvin or the thermodynamic scale of temperatures.

Let[51] Q be the quantity of heat given to a system at the temperature T° C. and the system undergoes a reversible isothermal change, then we can write

$$T = \frac{Q}{Q_{100°C.} - Q_{0°C.}} \cdot 100 \quad .. \quad .. \quad (16)$$

If further we assume that the equation of state of the gas is given by $pv = A$, where A is a function of the temperature alone, then the gas is known as an Avogadro gas and the temperature T_A on the Avogadro scale is given by

$$T_A = \frac{A}{A_{100°C.} - A_{0°C.}} \cdot 100 \quad .. \quad .. \quad (17)$$

The Avogadro scale and the Kelvin scale are identical so that $T = T_A$.

But no gas at our disposal is an ideal, or an Avogadro gas which obeys the law $pv = A$, where A is a function of the temperature, at all temperatures. We must therefore use only such gases, as hydrogen and helium. In the case of hydrogen and helium the deviations from the ideal gas relation are very small. The difference between the readings of an ideal gas thermometer and the helium thermometer are no longer negligible when we approach the boiling point of liquid helium. Within the limits of the experimental accuracy, the helium gas thermometer, gives us the temperatures on the Kelvin scale, in all regions of temperature except the liquid helium region.

The constant volume helium thermometer with an initial pressure of 100/76 atmosphere at 0° C., is called the international helium thermometer. The temperature on this scale is denoted by $T_{i\,He}$ (temperature international helium),

$$T_{i\,He} = \frac{p}{p_{100°C.} - p_{0°C.}} \cdot 100 \quad .. \quad .. \quad (18)$$

If we write for the mean coefficient of expansion $a_{i\,He}$ then

$$a_{i\,He} = \frac{p_{100°C.} - p_{0°C.}}{p_{0°C.} \cdot 100}$$

and the temperature $T_{i\,He}$ can be written as

$$T_{i\,He} = \frac{1}{a_{i\,He}} \cdot \frac{p}{p_{0°C.}} \quad .. \quad .. \quad .. \quad (19)$$

$a_{i\,He} = 0{\cdot}0036609$, while the corresponding coefficient of expansion[52] for an ideal gas is $a_A = 0{\cdot}0036611$.

Thus the general way of determining the absolute temperature consists in measuring the pressure-volume relation of helium, extrapolating it to density zero, and getting the absolute value of T by applying the law for an ideal gas.

In the liquid helium region (0·7° K to 5·0° K) where the temperatures are reached by allowing helium to boil under different pressures; the measurement of the vapour pressures itself will give us the corresponding temperatures. Various empirical formulæ were suggested by Keesom[53] and his results are given in Table II.

To measure still lower temperature we construct a thermodynamic scale of temperatures,[8, 54, 55] on which the magnetic

susceptibilities of certain salts can tell us the temperature reached. The first two laws of thermodynamics yield the equation

$$TdS = dE + pdV - HdI.$$

It is convenient to define the heat content $Q = E + pv - HI$, and since the pressure effects are negligible in the present connection, we shall drop the pv term. For a process at constant entropy $dE = HdI$ and

$$\Delta E = \int H \left(\frac{\partial I}{\partial H}\right)_S dH$$

also

$$\Delta I = \int \left(\frac{\partial I}{\partial H}\right)_S dH$$

$$Q = E_{H=0} + \int_0^H H \left(\frac{\partial I}{\partial H}\right)_S dH - H \int_0^H \left(\frac{\partial I}{\partial H}\right)_S dH$$

and

$$T = \frac{dE - HdI}{dS} = \left(\frac{\partial Q}{\partial S}\right)_H \quad .. \quad (20)$$

It is evident from the equation (20) that the measurements of energy, entropy and differential susceptibility determine the temperature on the thermodynamic scale.

According to Kürti and others,[55] if T_a is the temperature on some arbitrary scale, if dS is the change of entropy between the temperatures T_a and $T_a + d\ T_a$, and if dQ is the corresponding change in total heat; then assuming that the rates of variation of S and Q with respect to T_a are known, the temperature T on the absolute scale is given by the formula (21)

$$T = \left(\frac{\partial Q}{\partial T_a}\right)_H \Big/ \left(\frac{\partial S}{\partial T_a}\right)_H \quad .. \quad .. \quad (21)$$

To determine the variation of Q with respect to T_a we heat the specimen by a constant source of heat like the γ rays, and measure the rate of change of T_a with time; this enables us to calculate $\partial Q/\partial T_a$ to an accuracy of about 10%. The variation of S with respect to T_a can be obtained from the variation of S with respect to H. This last variation is determined by carrying out the adiabatic demagnetisation starting with various fields, and applying the law of Langevin and Brillouin.

In the magnetic method of cooling, we use substances for which $\chi = \text{constant}/T$. For such paramagnetic substances it is easy to construct a thermometer, using its susceptibility as a measure for the temperature. Simon[49] measures the susceptibility by bringing a system of two coils around the place where the salt is situated, and sending an alternating current through the primary coil, the induced e.m.f. in the secondary depends on the susceptibility of the salt. The induced e.m.f. is amplified and sent to a galvanometer. The system is so compensated that the deflections on the scale are proportional to the susceptibility and hence $1/T$.

In the method of Giauque and Mc Dougall,[89] the temperature is measured by putting a coil round the paramagnetic substance. The coil is connected with a ballistic galvanometer. The deflections of the galvanometer are calibrated from the vapour pressure of helium, to as low temperatures as possible. Lower temperatures than this are measured by extrapolation, and Giauque and Mc Dougall believe that the actual temperatures were probably lower than those determined by extrapolation.

de Haas and others[13] make the paramagnetic substance itself read its own temperature. They do not use a coil and a ballistic galvanometer, but measure the force acting on the substance in a non-homogeneous field, and calculate the susceptibility and the temperatures from this. The substance is suspended in vacuum from one arm of a balance, and this enables them to balance the force exerted upon the substance in a non-homogeneous field. The vacuum enclosure itself is placed in a Dewar flask filled with liquid helium under a reduced pressure and a temperature of 1·3° K. The Dewar flask is placed between the pole pieces of a powerful electromagnet. The force F exerted on the substance is given by $F = MV\chi H\ \partial H/\partial x$, where M is the Mol number. But as H and $\partial H/\partial x$ are constant in the experiment, and as Curie law is obeyed we get $\frac{T_2}{T_1} = \frac{F_1}{F_2}$.

For several measurements, *e.g.*, the measurements of specific heat, it is desirable to have at one's disposal a secondary thermometer that indicates quickly. For this purpose the resistance thermometer appears to be very useful. Keesom and Bijl[56] compared the platinum resistance thermometer with helium thermometer and found

values for the constants in the formula suggested by Henning and Otto.[57] This formula gives R/R_0 as a function of the temperature.

$$\frac{R}{R_0} = a + (bT + cT^2)\,D\left(\frac{100}{T}\right) + (d + eT + fT^2)\,D\left(\frac{230}{T}\right) \quad .. \quad (22)$$

where D's are the Debye function.

The temperature coefficient of resistance of most metals is practically zero in the liquid helium range. A large number of experiments were made to find out substances which can be used for resistance thermometry in this range. Babbit and Mendelssohn[58] find that a wire of 5% lead in silver is convenient in the range 7° K to 3° K. According to Keesom and Ende[59] phosphor-bronze that has not been annealed is extremely suitable in the range 4·2° K to 1° K.

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The Problem of Grassland Improvement in India.

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IT is well known that India has more number of cattle than it can support, and that therefore, its cattle and its dairy industry are of an inferior quality. Due to the keen interest His Excellency the Viceroy has been taking in this problem of prime importance to an agricultural country like India, a movement not merely for improving the breed of Indian cattle, but also for tackling problems of animal nutrition and grazing have come to the forefront. It must be borne in mind that in order to evolve and maintain improved breeds of cattle we must give not only sufficient food but the right kind of food for them. Now, the foods for cattle can conveniently be grouped under four headings: (1) natural grasses, (2) fodder crops, (3) silage and (4) concentrated material such as oil-cakes, etc.

If we desire to maintain our cattle in good health and if we wish to raise their capacity of milk production to its maximum, they must be fed on varying mixtures of the above forms of food.

So far as the fodder crops and concentrated foods are concerned we find that the amount of their supply is diminishing on account of the policy for larger and larger production of what are called "economic crops," and also on account of unrestricted exports of oil-cakes. Moreover, the cultivation of fodder crops depends upon irrigation, and this facility is not available everywhere in India. Again, the production of silage directly depends upon the production of surplus quantity of grass during the very short monsoon or upon a sufficient production of fodder crops; but the latter are possible only in irrigated areas. It follows therefore, that, ultimately we must look to our natural grasslands as the main source of food-supply for our cattle.

Now, if we have to depend upon our grasslands for the supply of essential food for our cattle, it is obvious that we should take immediate steps to grow "two blades of grass where one grew before". And, this is without doubt possible, if we know how to do it and if we go about doing it in the right way.

Photo by F. R. Bharucha.

Shows three stages of succession of vegetation from the mixed deciduous forests (in the background) to the present semi-natural grasslands (in the forefront), brought about by biotic factors. Intermediate shrub stage in the middle ground.

Before we can decide how to increase our production of grass, we must take a survey of the nature and conditions of our grassland areas. The following are some of the outstanding facts concerning our own grasslands, and such a survey is bound to reveal that:

1. India is climatically at a disadvantage, in that it has no natural grassland area. In fact, whatever grasslands we have, are but semi-natural, and have arisen from the destruction of forests.

2. India has been having a larger number of cattle than its grasslands could support. This has led to over-grazing of our grasslands resulting in the deterioration of our cattle stock.

3. Governments have no responsible Department,[1] Imperial or Provincial, which would follow a definite co-ordinated policy for the maintenance and improvement of our grassland areas and of our cattle by periodical scientific survey and consequent programmes for improvement. Thus upto now, in actual practice, the Government have not formulated or followed any systematic policy or method for procuring the best kinds of grasses to maintain our cattle, as is being done in Great Britain, Continental Europe, America, New Zealand, Australia and South Africa. Instead of this, the Forest, Revenue, Agriculture and other departments have been constantly exploiting grassland areas, each for its own reason for the increase of its revenues,[2] whereby our grassland areas are getting increasingly depleted.

4. Such a depletion of grassland areas has been creating a greater and greater congestion on them by over-grazing, so much so that (*a*) the existing grassland areas are losing even the naturally deficient grassland characteristics they possessed, (*b*) they are fast becoming wastelands, and (*c*) our already poorly bred cattle are going down in quality.

5. All this tends to suggest that if we do not take immediate steps, our grasslands are in danger of destruction ; and this will lead to a further deterioration of our cattle.

How best should we deal with this serious problem so that cattle-breeding may not only thrive, but even progressively evolve into a vital industry of India. The best way to begin with would be :

(1) to make detailed floristic and ecological surveys in a few selected, typical areas representing the several types of our grasslands as they exist under different climatic and edaphic conditions ;

(2) to map out these areas on the basis of vegetation units, *i.e.*, in terms of different types of areas with reference to the specific nature of the *Plant Association* prevalent in each.

(3) These two preliminary steps will enable us to make estimates of the actual quantity and quality of food-resources now available for our cattle. This must follow a detailed study of the soils and other environmental conditions of each of the plant associations in order that we may be thereby enabled to understand the qualities and deficiencies of the soils, with a view to employing appropriate methods to improve the same.

The specimen surveys of each type thus made will enable us to arrive at conclusions which will be generally applicable to other similar areas in the land. In short, a "*Vegetation Survey*" as described above is the primary need of our country.

But, *pari passu* we must take immediate steps to fence off or otherwise protect such big areas, as we find these are in danger of total destruction through further over-grazing.

To summarize, the main points for consideration at the present stage are :

(1) Specimen surveys of the vegetation of our grasslands on an ecological basis.

(2) Protection of our over-grazed grasslands by fencing off or otherwise, in order to check the process of total destruction with which our grasslands are threatened as also to allow relief for the natural regeneration of the vegetation.

(3) Frame up and work a system of *rotational grazing* in accordance with the character and capacity of each type of our grassland areas.

After these primary needs are fulfilled, we can go on to tackle the greater problems of (*a*) finding out the nutritive values of our grasses, (*b*) the effects of the application of different types of artificial and farm manures, (*c*) the introduction of new species of grasses, (*d*) experiments of seeding, and, finally, (*e*) the effect of different types of grasses on the health of the cattle and their milk-producing capacity.

I think such a programme of industrialisation of our grasslands and cattle-breeding can best be undertaken by a special department of the Government or by a *Research Institute entirely* devoted to the *study, care* and *management* of our grasslands and our cattle.

---

[1] So far there are only proposals for the formation of a Central and Provincial Fodder and Grazing Committee.

[2] *Re.* Punjab grasslands Dr. Gorrie says : "The Revenue Department is anxious to collect its revenue, the Forest Department to grow trees, the Agriculture Department to cultivate better-paying crops, the Veterinary Department to rear more stock, the local landowner to keep a stud bull, the Irrigation Department to find more canal water, the public health authorities to improve the drinking water ..... *These are all competing for the areas which should be the natural fodder reserves of the Province.*" And Dr. N. C. Wright affirms that this statement is true with equal force for the whole of India. (*Report on the Development of the Cattle and Dairy Industries of India*, 1937.)

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A New Continued Fraction.

The so-called half-regular continued fraction (C.F.) is defined by

$$b_0 + \frac{\epsilon_1}{b_1} + \frac{\epsilon_2}{b_2} + \cdots + \frac{\epsilon_n}{b_n} + \frac{\epsilon_{n+1}}{b_{n+1}} + \cdots$$

when $|\epsilon_n| = 1$, b_0 is any integer, b_n a positive integer ($n \geqslant 1$), $b_n + \epsilon_{n+1} \geqslant 1$ ($n \geqslant 1$) with $b_n \geqslant 2$ if final; it includes the simple continued fraction as a particular case. Many types of such continued fractions have been studied in the last fifty years, notably by Hurwitz, Minkowski, Vahlen and Tietze. Among them is a special variety designated 'Canonical' by Perron, in which the aggregate of complete quotients is characterised by the property of being greater than $\frac{\sqrt{5}+1}{2}$.

Of the various half-regular C.F. developments of quadratic surds, special interest may be attached to those which are periodic and contain the least number of recurring elements. The first suggestion of such a development came from Minnegerode in 1873. We here propose a new C.F. development which is distinct from Minnegerode's and is applicable only to quadratic surds, resulting in a new periodic half-regular C.F. with the least number of recurring elements. It is remarkable that such a development should be implied in the method sketched by the famous mediæval Indian mathematician Bhaskara (born 1114 A.D.) for obtaining the integral solutions of the indeterminate equation $X^2 - NY^2 = 1$, commonly and wrongly attributed to Pell (1610–1685 A.D.). It had been thought erroneously by various writers that Bhaskara's method also gave rise to the simple continued fraction. The present announcement is, therefore, intended to correct this view and lay bare for the first time the true nature of the new continued fraction implied in Bhaskara's method.

2. This new development will now be briefly described and a few properties noted without proof. Details are reserved for later publication.

Let $\frac{P + \sqrt{R}}{Q}$ be a surd in the standard form and a' the greatest integer in it, R being a non-square positive integer, and P, Q being any integers.

Then $\frac{P + \sqrt{R}}{Q}$ may be represented in one of two forms

(I) $a' + \frac{Q'}{P' + \sqrt{R}}$ or (II) $a' + 1 - \frac{Q''}{P'' + \sqrt{R}}$

(P', Q', P'', Q'' being all integers); and we choose a' or $a' + 1$ as the partial quotient for the continued fraction development according as (i) $|Q'| \lessgtr |Q''|$ if $|Q'| \neq |Q''|$ and (ii) $Q \lessgtr 0$ if $|Q'| = |Q''|$.

After making the appropriate choice of I or II, we write it in the form $b_0 + \frac{\epsilon_1 Q_1}{P_1 + \sqrt{R}}$ where $|\epsilon_1| = 1$ and $0 < \frac{Q_1}{P_1 + \sqrt{R}} < 1$; and proceed similarly with $\frac{P_1 + \sqrt{R}}{Q_1}$ for determining the next partial quotient, and so on.

Since it is easily seen that

$$\left|\frac{P'^2 - R}{P''^2 - R}\right| = \left|\frac{Q'}{Q''}\right| \text{ and therefore}$$

$$\left|P'^2 - R\right| \lessgtr \left|P''^2 - R\right| \text{ according as } \left|Q'\right| \lessgtr \left|Q''\right|,$$

our condition implies a choice of the nearest square to R and so, the above development may be justifiably called '*The nearest square continued fraction*' or *the Bhaskara continued fraction* on account of its being implicit in his method.

3. *Properties:*

(i) The nearest square C.F. development of a quadratic surd gives a periodic half-regular continued fraction in which the cyclic part is 'canonical' and the number of recurring elements is never greater than that in any other periodic half-regular continued fraction development. The number of terms in the acyclic part also cannot exceed the corresponding number in the simple continued fraction development by more than 3.

(ii) The square-root of a positive rational number, greater than 1 and not a perfect square, when developed as the nearest square C.F., has a period which begins immediately after the first term and ends with a partial quotient which is twice the first partial quotient, except when the rational number is of the form $n^2 + n + \frac{1}{2}$ (n being a positive integer). In the exceptional case, we have

$$\sqrt{n^2 + n + \tfrac{1}{2}} = n + 1 - \underset{\times}{\frac{1}{2}} + \underset{\times}{\frac{1}{(2n+1)}}$$

[*N.B.*—This exceptional case is excluded in the properties (iii), (iv), (v) below.]

(iii) When the recurring cycle of the standard surd $\frac{\sqrt{R}}{Q}$ (> 1) in the new development does not contain a complete quotient of the form $\frac{p + q + \sqrt{R}}{p}$, where $R = p^2 + q^2$ and p, q integers such that $p \geqslant 2q > 0$, the properties of the cycle simulate those of the simple continued fraction.

(iv) When $R = p^2 + q^2$, and p, q integers such that $p \geqslant 2q > 0$, there cannot occur in the cyclic part of $\frac{\sqrt{R}}{Q}$ (> 1), Q being a positive integer, more than one complete quotient of the form $\frac{a + b + \sqrt{a^2 + b^2}}{a}$ where $R = a^2 + b^2$, $a \geqslant 2b > 0$; while

$$\frac{a + b + \sqrt{a^2 + b^2}}{a}$$

itself, when developed as the new C.F. will not have in its acyclic and cyclic part more than one remote or immediate successor of the same form but distinct from it.

Thus, it is possible to have *two* but *not more than two* equivalent surds of the type $\frac{p + q + \sqrt{p^2 + q^2}}{p}$ ($p > 2q > 0$).

For example, $\frac{487 + \sqrt{101^2 + 386^2}}{386}$ and

$$\frac{513 + \sqrt{139^2 + 374^2}}{374}$$

are equivalent ($101^2 + 386^2 = 139^2 + 374^2$).

(v) If $\frac{\sqrt{R}}{Q}$ (> 1) has in its recurring period in the new development a complete quotient of the form $\frac{p + q + \sqrt{p^2 + q^2}}{p}$ [defined as in (iv) above], the cyclic part may be said to be '*almost*' symmetric being in

the form

$$b_0 + \underset{\times}{\frac{\epsilon_1}{b_1}} + \cdots + \frac{\epsilon_v}{b_v} + \cdots + \frac{\epsilon_{v+r}}{b_{v+r}} + \cdots + \underset{\times}{\frac{\epsilon_{2v}}{2b_0}}, \text{ where}$$

$$b_v = 2, \epsilon_v = -1, b_{v-1} = b_{v+1} + 1, \epsilon_{v+1} = 1 \text{ and}$$

$b_{v+r} = b_{v-r}$, $\epsilon_{v+r} = \epsilon_{v-r+1}$ $(v \geqslant r > 1)$ which give the symmetries for b's and ϵ's.

(vi) The period of the square-root of a non-square positive integer has an even number of terms in the case contemplated in (v); and the denominators of the complete quotients up to the end of the period form a symmetric sequence of an odd number of terms with the middle term greater than 4.

Example: $\sqrt{58} = 8 - \underset{\times}{\frac{1}{2}} - \frac{1}{2} + \frac{1}{2} - \underset{\times}{\frac{1}{16}}$ and the denominators of 2nd, 3rd and 4th complete quotients can be verified to be 6, 7, 6 respectively.

4. Associated with this new continued fraction there is a theory of reduced quadratic forms, which remains to be fully worked out. The complete system of indefinite, primitive reduced forms for any given non-square positive integral determinant R consists of forms of the type (A, B, C) satisfying one of the following three sets of conditions:

(i) $B > 0$, $A^2 + \frac{1}{4}C^2 < R$, $C^2 + \frac{1}{4}A^2 < R$

(ii) $B = |C| + \frac{1}{2}|A| > \sqrt{R}$, $|A| < |C|$, $C^2 + \frac{1}{4}A^2 = R$

(iii) $B = |A| - \frac{1}{2}|C| < \sqrt{R}$, $|A| > |C|$, $A^2 + \frac{1}{4}C^2 = R$

If $A^2 + \frac{1}{4}C^2 = R = C^2 + \frac{1}{4}A^2$, the form (A, B, C) is not primitive except when $R = 5$.

A. A. Krishnaswami Ayyangar.
Maharaja's College,
Mysore,
May 27, 1938.

Friedel-Crafts Reaction with Diethers of Resorcinol.

Simonis and Lear[1] claimed that O-diethylresorcinol with cinnamoyl chloride in presence of aluminium chloride gives 2 : 6-diethoxyphenyl styryl ketone, the cinnamoyl radical entering the nucleus in the 2-position between the two alkoxyl groups. Simonis and Danishewski[2] made a similar claim for O-dimethylresorcinol, and cinnamoyl and phenylpropioloyl chlorides.

On general grounds direct substitution in the 2-position of resorcinol is unlikely; acetyl chloride for example enters the 4-position. A re-examination of the work has shown that cinnamoyl chloride also enters in the 4-position to give chalkones identical with those obtained from the corresponding O-dialkylresacetophenones by condensation with benzaldehyde; further the chalkones obtained from 2-acetyl-O-dialkylresorcinols and benzaldehyde differ from those described by Simonis. The whole of the work is under process of repetition. In the preparation of O-diethyl-2-acetylresorcinol indications of nuclear ethylation have been obtained.

It may be mentioned that Monti[3] claims that β-naphthyl methyl ether is substituted by cinnamoyl chloride in the 3-position; this again is doubtful; entry in the 1-position is more likely.

D. C. Motwani.
V. V. Bodani.
T. S. Wheeler.
Royal Institute of Science,
Bombay,
May 12, 1938.

[1] *Ber.*, 1926, **59**, 2912.
[2] *Ibid.*, 1926, **59**, 2916.
[3] *Gazz. chim. ital.*, 1930, **60**, 43.

Preferential Demethylation of Methoxyl Ortho to a Keto-group.

Preferential demethylation of a methoxyl group situated in the ortho-position to a keto-group is known to be effected by treatment with aluminium chloride. It has now been found that such preferential demethylation can be achieved in satisfactory yield if the ketone is kept for some twenty-four hours in cold solution with hydrogen iodide in acetic anhydride or with hydrogen bromide in glacial acetic acid. For example, when a mixture of 2 : 4 : 6-trimethoxyacetophenone (5 g.), hydriodic acid (d., 1·7; 40 c.c.) and acetic anhydride (40 c.c.) which had been kept in the cold for 24 hours is diluted with sodium hydrogen sulphite solution, 2-hydroxy-4 : 6-dimethoxyacetophenone is obtained in 80 per cent. yield. The usual method employing aluminium chloride has here been found to give 60 per cent. yield.

Alkoxylated derivatives of *o*-methoxyphenyl styryl ketones can also be preferentially demethylated to the *o*-hydroxy-compounds in this manner.

W. A. HUTCHINS.
T. S. WHEELER.

Royal Institute of Science,
Bombay,
May 12, 1938.

Flavones from the Dibromides of *o*-Hydroxyphenyl Styryl Ketones. A Modified Synthesis of Apigenin and Luteolin.

IT has previously been pointed out[1] that the dibromides of certain *o*-hydroxyphenyl styryl ketones which normally yield benzylidenecoumaranones only on treatment with alcoholic alkali, can be converted into flavones by simple heating. It has now been found by several workers in this laboratory that better yields of the flavones can be obtained if the hydroxy-dibromide is treated with alcoholic potassium cyanide. Further, *o*-hydroxyphenyl *α*-bromo-*β*-ethoxy-*β*-alkoxyphenylethyl ketones which give benzylidenecoumaranones with alkali hydroxide or carbonate in presence of hot or cold acetone or alcohol, give flavones with alcoholic potassium cyanide.

2-Hydroxy-4 : 6-dimethoxyphenyl *p*-methoxystyryl ketone on bromination gives *5-bromo-2-hydroxy-4: 6-dimethoxyphenyl αβ-dibromo-β-p-anisylethyl ketone* which on heating yields *6-bromo-5 : 7 : 4′-trimethoxyflavone*; this with hydriodic acid gives apigenin (5 : 7 : 4′-trihydroxyflavone). Luteolin (5 : 7 : 3′ : 4′-tetrahydroxyflavone) has been synthesised by heating *5-bromo-2-hydroxy-4 : 6-dimethoxyphenyl αβ-dibromo-β-3 : 4-dimethoxyphenyl ethyl ketone* with alcoholic potassium cyanide and treating the resulting *bromoflavone* with hydriodic acid.

The synthesis of 5 : 7 : 2′ : 4′-tetrahydroxy-flavone which is thought to be lotoflavin is now in hand.

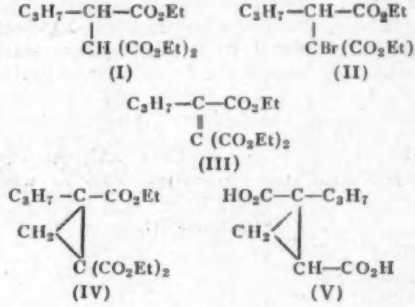
W. A. HUTCHINS.
T. S. WHEELER.

Royal Institute of Science,
Bombay,
May 12, 1938.

[1] *Curr. Sci.*, 1937, **5**, 475; *J.C.S.*, 1937, 1800.

A New Method of Synthesis of Umbellularic Acid.

UMBELLULARIC acid, a degradation product of the naturally occurring bicyclic ketone umbellulone, has been synthesised by two methods.[1, 2] It has now been synthesised by a convenient method starting from ethyl *α-iso*propyl-*α′*-carbethoxy succinate (I) which gives readily the bromo-compound (II) (b.p. 155–56°/3 mm.; Found: Br, 21·40; Calc.: Br, 21·86 per cent.). The bromo-compound (II) loses a molecule of hydrobromic acid by the action of diethylaniline yielding ethyl *iso*propyl-carboxyfumarate (III), b.p. 135–40°/3 mm., which readily adds on a molecule of diazomethane to yield the *cyclo*propane-tricarboxylic ester (IV) (b.p. 148–50°/3 mm.; Found: C, 59·46; H, 8·34; Calc.: C, 60·0; H, 8·0 per cent.). The triester (IV) on being boiled with hydrochloric acid (18 per cent.) during eight hours got hydrolysed and decarboxylated and yielded *trans*-umbellularic acid (V) (m.p. 190–92°; Found: C, 55·63; H, 7·26; Calc.: C, 55·81; H, 7·0 per cent.). The *trans*-acid (V) has been converted into the *cis*-variety (monohydrate, m.p. 94–95°) by treating with acetyl chloride and its identity has been proved by taking mixed m.p. with a genuine sample obtained by older methods.



P. C. GUHA.
M. S. MUTHANNA.

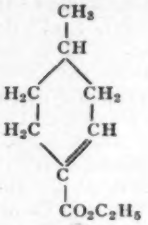
Department of Organic Chemistry,
Indian Institute of Science,
Bangalore,
May 3, 1938.

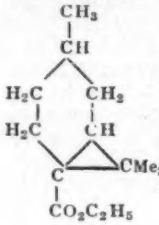
[1] Rydon, *J.C.S.*, 1936, 829.

[2] Ranganathan, *J. Ind. Chem. Soc.*, 1936, **13**, 419. Simonsen, *J.C.S.*, 1936, 828.

Synthesis of Carane.

In the present communication, the synthesis of carane starting from a *cyclo*hexene derivative, possessing a methyl group in position 1, and a double bond between the carbon atoms in positions 3 and 4, is described. The starting substance was ethyl Δ^1-tetrahydro-*p*-toluate, obtained in an improved yield according to the method of


(I)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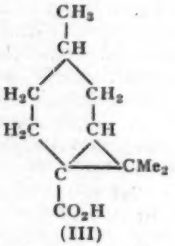
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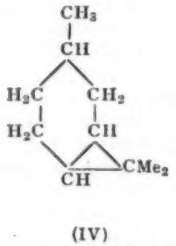
(IV)

Bardhan[1] starting from *p*-methyl *cyclo*hexanone. The unsaturated compound (I) reacts with dimethyl-diazomethane on being allowed to stand at 0° during two weeks to yield the bi*cyclo* (0 : 1 : 4)-heptane derivative (II) (b.p. 150 — 160°/6 mm.) giving on hydrolysis with 5 per cent. alcoholic potassium hydroxide the corresponding carboxylic acid (III), m.p. 104—105°; Eq. Wt. Found : 181·2; required, 182. The acid on being distilled with ZnO–BaO under reduced pressure gives a compound which from its boiling point (Found : 161°/684 mm.; known, 169°/750 mm.), refractive index (Found : 1·4553; known, 1·4567) and the characteristic smell appears to be carane (IV). It is to be mentioned that the present synthesis constitutes the first total synthesis of a bicyclic compound of the carane series.

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Bangalore,
May 3, 1938.

[1] *J.C.S.*, 1935, 478.

Rottlerin—Part IV.

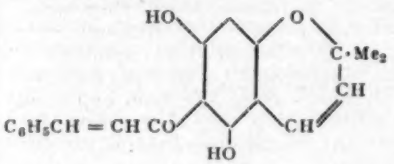
In Part III, we have advocated the view that rottlerin is best represented by the formula $C_{31}H_{30}O_8$ containing five hydroxyl groups which are methylated by dimethyl sulphate and potassium bicarbonate in acetone solution. Since then, McGooken, Percival and Robertson[1] have stated that all their previous published data are equally explainable on the basis of $C_{30}H_{28}O_8$ (pentahydroxy) formula as against $C_{32}H_{30}O_9$ (hexahydroxy) formula which they once considered to be possible.[2] Although it is difficult to pronounce a final opinion on this question, yet our results, notably the oxide and the nitrosite, are best explained on the basis of a C_{31} formula for rottlerin. Hoffmann and Fari[3] advocated a C_{31} formula mainly on the analysis of the sodium salt. Therefore, the present indications are that probably rottlerin is C_{31} but as we have already mentioned this question will not be solved finally before more data accumulates.

Robertson *et al*[1] described a substance $C_{20}H_{18}O_4$ obtained by the alkaline hydrolysis (barium hydroxide) of rottlerin, which they called rottlerone. We found[4] that the hydrolysis of tetrahydrorottlerin with aqueous alcoholic hydrochloric acid gave a substance $C_{20}H_{22}O_4$ ($\pm 1\ CH_2$) which we suggested might be identical with tetrahydrorottlerone described by Robertson *et al*. We have now methylated our product and find it to be so. In this connection we wish to state that this substance $C_{20}H_{22}O_4$ is obtained in a much greater yield by the acid hydrolysis described by us (3·2 g. from 8·0 g. of tetrahydrorottlerin) whilst Robertson *et al* obtained 5 to 6 gr. from 20 g. of tetrahydrorottlerin by the sodium hydroxide hydrolysis. Under the following conditions, the yield stated above can be easily obtained.

Tetrahydrorottlerin (8 g.) in alcohol (400 c.c.), hydrochloric acid (d. 1·14, 80 c.c.) and water (40 c.c.) was heated for 26 hours. The substance was obtained by filtering the mixture hot as an insoluble powder which crystallised from ethyl acetate. If in the above experiment the reaction mixture is cooled and diluted after 8 hours heating, a light brown substance is precipitated which is soluble in sodium bicarbonate and behaves like an unstable acid. Owing to the ease of decomposition, it has not been possible to get it in a pure form but it is certain that it is an acid and also this very substance

in alcoholic hydrochloric acid solution on further heating becomes converted to tetrahydrorottlerone. This fact is significant and it will not do to ignore it in assigning a structure to rottlerin. Along with this, we have also to remember that rottlerin is never recovered completely back from its alkaline solution indicating some kind of lactonic or ester linking.

Robertson *et al* have advanced the formula (I) for rottlerone.



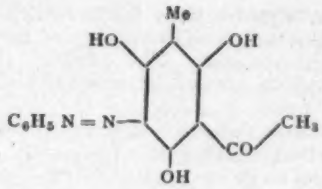
(I)

We are unable to subscribe to this view on the following grounds :—

(*a*) We could not get any evidence of a ketonic group in tetrahydrorottlerone methyl ether.

(*b*) We obtained no indications of the formation of pyrillium salt when tetrahydrorottlerone methyl ether was saturated with hydrogen chloride at 0° in ether solution along with salicylaldehyde.

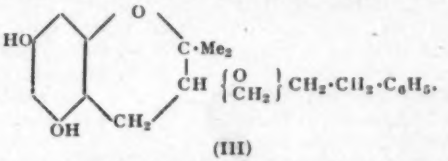
Robertson *et al* have suggested a tentative formula for rottlerin in which an additional $CO \cdot CH_3$ has been postulated in the second part of the molecule. This again we consider to be most improbable in view of our failure to get an oxime or a semicarbazone. We have treated pentamethoxy rottlerin and pentamethoxy tetrahydrorottlerin with sodium hypobromite and obtained no indication of the formation of bromoform. Under these circumstances we cannot accept the presence of a $CO \cdot CH_3$ group. Brockman and Maier[5] have obtained an azo-derivative (II) by the action of diazobenzene chloride on rottlerin. This would indicate that there exists a $CO \cdot CH_2$ group in the rottlerin molecule but



(II)

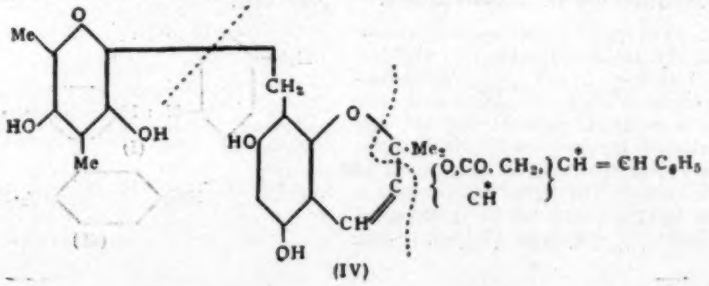
we think that this substance is formed by the simultaneous hydrolysis of the chromene ring and the extrusion of the second half of the rottlerin molecule.

In one experiment we obtained phthalic acid as one of the products when we oxidised methyl ether of rottlerin with chromic acid but the exact conditions were not known and since then we have failed to repeat this experiment. If phthalic acid is an oxidation product, it can only be indirectly formed. Therefore we are inclined to remove the group $Ph \cdot CH = CH \cdot CO$ of Robertson's formula (I) from the phloroglucinol ring and place it adjacent to the chromene ring. Moreover in absence of any proof for the existence of the CO group we are inclined to think that there is a lactonic grouping in association with the chromene ring. Therefore, we suggest tentatively that tetrahydrorottlerone has an arrangement similar to III.



(III)

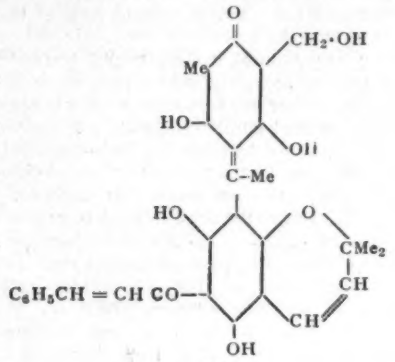
The analytical data (C and H values) for the methyl ether of tetrahydrorottlerone agrees with a trimethyl ether but difficulties are experienced in the formulation of the acetyl derivative. In our opinion the part in bracket arises from the opening up of a lactone ring and we think that rottlerin has an arrangement similar to (IV). If ultimately



(IV)

rottlerin is proved to be C_{30} then the CH and H marked with * will have to be taken off from the formula. The product (II) of Brockman is formed by scission along the dotted lines.

Prof. Robinson, to whom we wrote about the rottlerin problem, has very kindly suggested to us in a letter dated 23rd April 1938 the following as the probable constitution (V) of rottlerin based mainly on the rottlerone work of Robertson.



(V)

We are engaged in testing the validity of the formula so kindly suggested by Prof. Robinson.

K. S. NARANG.
J. N. RAY.
B. S. ROY.

The University,
Lahore,
May 7, 1938.

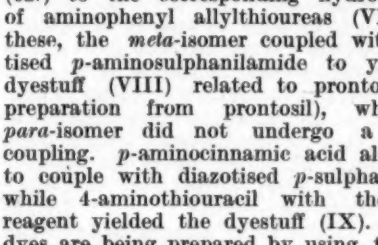
[1] *J.C.S.*, 1938, 309.
[2] *Ibid.*, 1937, 748.
[3] *Arch. Pharm.*, 1933, 99.
[4] *J.C.S.*, 1937, 1862.
[5] *Naturwiss.*, 1937, 460.

The Chemotherapy of Tuberculosis.

THE recent discovery of the specific action of Prontosil (I), sulphanilamide (II) and the diacetyl derivative of 4 : 4′-diaminodiphenyl sulphone (III) in infections due to the *cocci* and other bacteria[1] led the present author to try some of the derivatives of the above compounds in the case of tuberculosis also. The general procedure adopted is to react the amino-groups of the compounds (I), (II) and (III)—as such and also their derivatives—with allyl mustard oil to yield compounds (with allylthiourea groupings) resembling 'lopion' (the gold salt of IV) which is known to be least toxic and not deranging the kidneys.

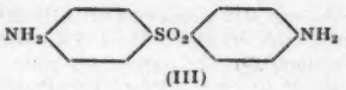
Thus *para*-aminobenzene sulphonamide (II), *para*-aminocinnamic acid, *para*-amino mandelic acid and 4 : 4′-diaminodiphenylsulphon (III), yielded the corresponding allylthiourea derivatives with allyl mustard oil. Sulphanilic acid, however, did not undergo a similar condensation. It furnished with *p*-acetaminobenzenesulphonic chloride in alkaline solution *p*-acetaminobenzene sulphonamino benzene sulphonic acid (V) which was hydrolysed to the corresponding amine and the latter with allyl mustard oil yielded the allylthiourea derivative.

Prontosil (I) condensed with allyl-mustard oil to yield the allylthiourea derivative. Though *meta*- and *para*-phenylenediamines yield only monothioureas with one molecule of potassium thiocyanate, it has now been found that even with one molecule of allyl mustard oil the above diamines furnished almost exclusively phenylene di-allylthioureas. However *m*- and *p*-acetphenylenediamines condensed with allyl mustard oil to the corresponding acetaminophenyl allylthiourea derivatives (VI) which were hydrolysed with hydrochloric acid (6N) to the corresponding hydrochlorides of aminophenyl allylthioureas (VII). Of these, the *meta*-isomer coupled with diazotised *p*-aminosulphanilamide to yield the dyestuff (VIII) related to prontosil (*vide* preparation from prontosil), while the *para*-isomer did not undergo a similar coupling. *p*-aminocinnamic acid also failed to couple with diazotised *p*-sulphanilamide while 4-aminothiouracil with the same reagent yielded the dyestuff (IX). Similar dyes are being prepared by using the compound (III) in place of (II) in the above reactions.

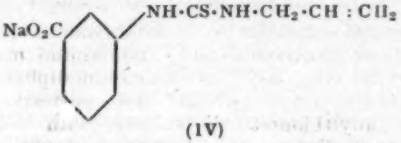


(I)

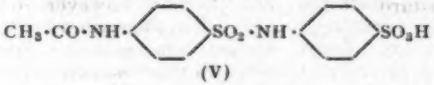
(II)



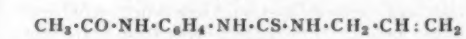
(III)



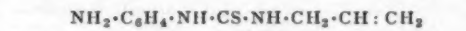
(IV)



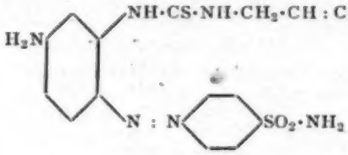
(V)



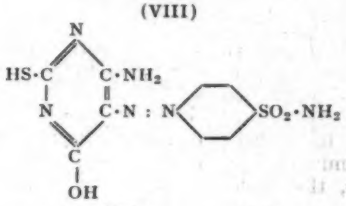
(VI)



(VII)



(VIII)



(IX)

Under the usual conditions, all the above compounds described yield gold salts, the pharmocological examinations of which are being carried out elsewhere.

Full details of the experiments will be published elsewhere.

The author thanks Dr. P. C. Guha for his kind interest in this work.

K. Ganapathi.

Department of Organic Chemistry,
Indian Institute of Science,
Bangalore,
April 28, 1938.

[1] Buttle, *Proc. Roy. Soc. Med.*, 1937, **31**, 154; *cf. Annales Medico-chirurgicales*, 1938, **3**, No. 3.

Non-Protein Nitrogen of Vegetables.

It is well known that many food-stuffs, vegetables, pulses, etc., contain considerable amount of non-protein nitrogen (McCance,[2] Bhagvat and Sreenivasaya[3] and Swaminathan[1]) which may exist as simple derivatives of proteins, amino acids and other nitrogenous substances, not precipitated by majority of common protein precipitants. The exact rôle of non-protein nitrogen in protein metabolism is still not known. The study of the amino acid make-up of this fraction is important on account of (1) its nutritive value, (2) its physiological relationship with the proteins of the vegetables. The non-protein nitrogen make-up of the vegetables, Drumstick leaf, Drumstick, Amaranth and Cabbage have now been partitioned by the Van Slyke's method and independent determination of the essential amino acids has been carried out.

The values are given below:

Table I.

Percentage of Total Nitrogen.

Form of nitrogen	Drumstick leaves	Drumstick	Amaranth	Cabbage
Acid sol. Humin ..	5.25	2.3	1.5	0.86
Acid insol. Humin ..	5.25	2.3	5.6	1.08
Amide	7.89	6.9	11.2	3.44
Total Basic Nitrogen ..	34.21	26.4	22.7	38.07
Amino	10.52	2.5	6.7	11.9
Non-amino	23.69	23.9	16.0	26.17
Total non-basic nitrogen ..	47.37	62.1	59.0	57.4
Amino	31.58	32.5	25.1	30.0
Non-amino	15.79	29.6	33.9	27.4
Arginine (Basic fraction)				
Van Slyke	22.9	24.4	22.5	27.7
Arginine (direct) ..	51.1	36.2	42.9	44.6
Arginine in (Non-basic fraction)	..	..	23.9	18.2

Table I reveals important differences in the nitrogen make-up of non-protein fractions. In all the four cases investigated, the value of the non-basic non-amino nitrogen is very high, showing thereby that it may be due to a high content of proline and hydroxy-proline. The fact that the non-basic fraction gives off ammonia on hydrolysing it with 25% alkali suggests

that there are substances besides proline and hydroxy-proline whose nature is not yet known, and which interferes in the nitrogen distribution studies by the Van Slyke method.

Further investigation on the nature of these substances is under investigation.

Y. V. S. RAU.
V. RANGANATHAN.

Department of Biochemistry,
Indian Institute of Science,
Bangalore,
May 28, 1938.

[1] *Ind. Jour. Med. Res.*, 1938, **25**, 847.

[2] "The chemistry of flesh foods and their losses on cooking," *M.R.C. Report*, **187**, 22.

[3] *Biochem. J.*, 1935, **29**, 909.

Tartaric Acid from the Tamarind Fruit.

CONSIDERABLE quantities of tartaric acid are imported into India in spite of the large availability of certain raw materials for it in several parts of the country. Thus, the pulp of the ripe tamarind fruit has been found to contain nearly 5 per cent. of free tartaric acid and about 8 per cent. as cream of tartar. In view of this rich source for this acid Sudborough and Vriddhachalam[1] investigated the possibility of extracting the same from the ripe fruit but their yield was not quite satisfactory while the cost of production was somewhat high. Subsequently, Marsden[2] modified the method of extraction to yield a slightly better product. He fermented also the aqueous extract to produce alcohol as a by-product from the sugar contained in it, thereby reducing the cost of manufacture. Apart from the mechanical difficulties experienced in separating the slimy pulp from the extract, the final product obtained is contaminated with pectin which has been shown to be present in it by Franzen and Kaiser[3] and which is extracted along with tartaric acid through cooking the pulp at higher temperatures.

It is well known on the other hand, that the green fruit tastes to the palate sharp and acidic. With a view to investigating the tartaric acid content of the raw fruit, the following procedure was adopted: One pound of the fresh fruit (big and green) was ground to a uniform pulp along with the pericarp. The mashed pulp was mascerated with cold water (with added preservative) and subsequently extracted with cold water in a percolator till three litres of the percolate were collected. The residual pulp did not react acidic to blue litmus. Presumably, all the free acid was extracted hereby. The collected percolates were concentrated under reduced pressure at 60° C. to a volume of 250–300 c.c. After cooling, it was treated with 150 c.c. of 95 per cent. alcohol to precipitate pectins, etc. that might have been extracted and filtered. The filtrate was further treated with 50 c.c. alcohol, 10 c.c. glacial acetic acid and 25 c.c. of a saturated solution of potassium chloride with vigorous stirring. Crystals of cream of tartar began to separate soon and the entire solution was preserved in a cool place. Next morning it was filtered on a Buchner funnel, washed with 30 per cent. alcohol and dried in an oven at 100° C. The results obtained with three different specimens are reproduced below:

Free tartaric acid content of the unripe tamarind fruit.

Weight of fruit in grams	Weight of cream of tartar in grams	Percentage of tartaric acid		Purity of cream of tartar
		In fresh fruit	In dry fruit	
450·0	21·6	3·8	17·1	97·8
450·0	20·1	3·5	16·6	98·9
450·0	19·8	3·4	16·4	98·7

The purity of cream of tartar was checked against alkali standardised against extra pure cream of tartar.

In the residual mash combined tartaric acid amounted to less than 0·5 per cent. on dry weight basis.

It is abundantly clear from this that the green fruit is a better source for tartaric acid than the ripe one, although the latter is more readily stored and available at all periods of the year. This is further supported by the fact that the unripe material contains free acid to the extent of over 16 per cent. while the ripe one has nearly 7 per cent. of it on dry basis. The method of cold extraction also would be simple in the case of the unripe fruit, while with the ripe one, considerable difficulties are encountered.

Moreover, by the cold method of extraction, the solubilisation of pectins can be minimised.

A. V. Varadaraja Iyengar.

Department of Biochemistry,
Indian Institute of Science,
Bangalore,
May 21, 1938.

[1] *Jour. Indian Inst. Sci.*, 1920-21, **3**, 72.
[2] *Ibid.*, 1923, **5**, 137.
[3] *Zeit. Physiol. Chem.*, 1923, **128**, 290.

Powdery Mildew of Betel Vine.

Of recent years powdery mildew has been doing much damage to betel vines in Bassein near Bombay. The disease is, however, localised in this area since it has not yet been reported from other parts of the Province of Bombay. The mildew usually makes its appearance during the cold months and practically disappears as the hot weather approaches. Older plantations are more liable to attack than newly planted vines.

The disease is easily recognised by the appearance of yellow spots, which are slightly raised and irregular in outline, and correspond in extent to white powdery patches of mildew on the under surface of the leaves. The patches of mildew are also sometimes found on the upper surface of the leaves. These patches are at first small but increase in extent as they grow together.

Field trials made during the past few years have shown that dusting of betel vines with sulphur of the order of 200 mesh fineness results in complete control of mildew. Usually one application of sulphur dust is sufficient for effective control, but in older gardens two dustings are generally required. In the absence of the treatment the leaves have to be plucked as soon as they are ready for harvest; otherwise they are disfigured by spots and drop down if infection is severe. Apart from checking mildew, sulphur dusting has therefore the effect of prolonging the life of the leaves which can be harvested to suit the market conditions.

The causative fungus of powdery mildew of betel vines is an ectophyte which feeds by sending globular haustoria into the epidermal cells of the leaf. The fungus is new to science, and the name proposed for it is *Oidium piperis* spec. nov.

A detailed account of this investigation together with the technical description of the causative fungus will be published in a separate communication.

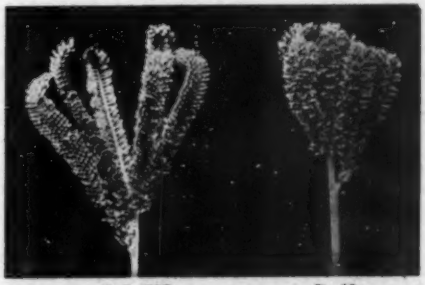
B. N. Uppal.
M. N. Kamat.

College of Agriculture,
Poona,
May 3, 1938.

R. 42—An Economic Recessive Mutant from E.C. 593 *Ragi (Eleusine coracana* Gaertn.).

In 1934, at the Agricultural Research Station, Hagari, a single plant with "In-curved" ears was spotted in a half-an-acre plot of E.C. 593 *ragi*, a strain of *Eleusine coracana* Gaertn. with "Top-curved" ears. This odd plant was labelled R. 42 (R = *Ragi*) and it has bred true to all its characters during the three years it has been under culture.

The authors are of the opinion that this plant arose from E.C. 593 by mutation. The seed of E.C. 593 was obtained from the Millet Breeding Station, Coimbatore, in May 1933. It was under comparative trial in that year (1933–34) with Type-8 *ragi*. No other strain of *ragi* was grown on the Station in that season. Any question of the plant being a mixture of, or a cross with Type-8 is ruled out, as the latter is deeply purple pigmented and R. 42 is a green throughout. In this crop purple pigment is dominant to green throughout.[1] The plant resembles E.C. 593 very closely in all morphological characters such as habit, stem, leaf-shape, etc., except in the shape of ear-head (Fig. 1). The following measurements made on 100 plants in each of these strains amply support this view, *viz.*, that the plant has arisen only by mutation.



E.C. 593. R. 42.

Strain		Height of plant (cm.)	Number of tillers		Number of fingers	Length of finger (cm.)	Length of peduncle (cm.)
			Primary	Secondary			
E.C. 593	Max.	105.0	4.0	3.0	7.0	11.5	38.0
	Min.	82.0	1.0	1.0	4.0	7.5	18.5
	Average	92.8	1.8	0.7	5.3	9.3	27.3
R. 42	Max.	105.0	4.0	2.0	10.0	7.5	32.0
	Min.	68.0	1.0	1.0	4.0	5.0	16.0
	Average	89.5	1.8	0.4	6.4	6.2	23.6

Note.—The larger number of fingers with shorter length and lower emergence of R. 42 are in accordance with the characteristics of plants possessing "In-curved" panicles.

It is highly interesting that E.C. 593 from Coimbatore when grown at Hagari has given rise to this mutant. As the difference between the parents and the mutant is in the shape of the ear-head alone, the change seems to have taken place in a single gene only as the "In-curved" head is a simple recessive to the "Top-curved".[2]

R. 42 was under comparison with E.C. 593 and other varieties of *ragi* for three seasons from 1935 to 1937. In all these years it was the heaviest yielder, giving 9 to 10 per cent. higher yield of grain over E.C. 593.

It is extremely interesting that the loss of a gene should have proved economic, as in nature the occurrence of economic recessive mutants is very rare. E.C. 593 is an excellent strain of *ragi* and the only objection of the cultivators to take this strain has been the shape of its panicle. R. 42 with a type of ear-head that suits the fancy of the cultivators of this tract, it is hoped, will prove more successful in its spread than its parent, E.C. 593.

C. VIJAYARAGHAVAN.
P. SESHADRI SARMA.
The Agricultural Research Station,
Hagari,
May 9, 1938.

[1] Rangaswami Ayyangar, G. N., and Krishna Rao, P., *Ind. J. Agric. Sci.*, 1931, 1, 434.
[2] —, *et al*, *ibid.*, 1932, 1, 254.

Sorghum—Purple Pigment in the Late-Seedling Stage.

SORGHUM plants may be purple pigmented or green throughout. The pigmented condition is best seen in the adult plants when the tissues begin to dry up. The parts that show the pigment best are the leaf-sheaths and the glumes. These may be coloured reddish-purple or blackish-purple. Factors P and Q are responsible for these characters.[1]

As against this manifestation of purple pigment at the adult stage, sorghum seedlings could, in the very early stages, be separated into those with purple coleoptile and those with green coleoptile. These seedlings may have roots with or without purple pigment.[2, 3]

In addition to these ordinary manifestations, the purple pigment may show itself at a special stage in the life of the plant. In certain varieties of African sorghum when the heads emerge from the boot, the glumes are tinted purple. Factor G_{ep} is responsible for this special manifestation.[4]

A new type of specialised manifestation of the purple pigment in the life-history of the sorghum plant has recently been met with. In this type, the pigment manifests itself in the late-seedling stage. Usually, whenever the coleoptile is coloured purple the first two seedling leaves are also tinged purple. From the third leaf onwards, they usually remain green without showing purple colour. In this new type of manifestation the purple pigment (which is anthocyanic) manifests itself from the 3rd seedling-leaf up to the 8th or even the 10th seedling-leaf. Leaves above this, continue to be green. This manifestation is independent of whether the coleoptile is purple or green. In the field, pigmented seedlings from 25 to 35 days old stand out well marked from the green seedlings. The pigment is in the nature of a splash and is deeper on the under-surface of the leaf-blade. It is more prominent at the edges of the blade. In the sheath, the colour is deeper towards the base. The junction area (the specialised triangular tissue at the junction of the leaf-blade and the leaf-sheath) is free from this pigment. The tint of the pigment varies slightly between varieties but the steadiness of this late-seedling manifestation is constant within the variety. If this character is missed in the 25 to 35 days stage, it could be picked up in the

young side-shoots and tillers. Like the bluish-green and the green seedling character,[5] this disappears from the seedling stage to reappear in the vegetative shoots at the adult stage. In this latter manifestation, the tint of the purple pigment is deeper than in the late-seedling stage.

Plants manifesting this late-seedling-purple character have usually blackish-purple leaf-sheaths, purple axils and green nodal bands.[3,6] This character is independent of the emerging purple glume character.[4]

In the wild sorghums, this character of the late-seedling-purple is manifested in a few types belonging to *S. virgatum* and *S. verticelliflorum* of the sub-section Arundinacea[7] and also in a few types of *S. halepense*. In the cultivated races of sorghum this character is met with only in some varieties from Africa. They come from North-Rhodesia, Tanganyika, Belgian Congo and Abyssinia. They belong to the groups *S. caffrorum*, *S. nigricans*, *S. coriaceum* and *S. caudatum* of the Caffra sub-series, to *S. elegans* of the Bicoloria sub-series and to *S. conspicuum* of the Guineensia sub-series.[7]

In crosses between late-seedling-purple and late-seedling-green varieties, the first generation plant showed late-seedling-purple. In the F_2-generation there was a segregation giving 1,180 purple to 388 green. A third generation was raised consisting of 8 purple and 2 green selections. The two green-seedling selections bred true. Of the 8 purple selections two bred true to purple and six segregated again giving a total of 2,256 purple and 704 green seedlings. This experience has been repeated in four other independent families which gave a total of 1,016 purple and 341 green seedlings.

The above experiences were obtained in crosses between varieties belonging to the Caffra sub-series of sorghum. In further crosses involving *S. margaritiferum* and *S. roxburghii* var. *hians*, both belonging to the Guineensia sub-series, the same monogenic segregation was met with. *S. margaritiferum* is African and *S. roxburghii* var. *hians* is Indian in origin and in both these varieties the late-seedling colour is green. In crosses with *S. margaritiferum*, there was a segregation giving 1,033 purple and 347 green seedlings and in the *S. roxburghii* cross the numbers were 818 purple and 270 green.

It will thus be seen that a gene designated P_{LS}, African in origin is responsible for the manifestation of purple pigmentation in the seedlings about a month old. The local Indian sorghums lack this character and in them the seedlings remain green at this stage. P_{LS} is a simple dominant to P_{ls}.

G. N. Rangaswami Ayyangar.
B. W. X. Ponnaiya.
T. Venkataramana Reddy.
Agricultural Research Institute,
Coimbatore,
June 3, 1938.

1 *Indian Jour. Agric. Sci.*, 1933, **3**, Pt. IV, 589–604.
2 *Agric. Jour. Ind.*, 1930, **25**, Pt. III, 262–63.
3 *The Madras Agric. Jour.*, 1934, **22**, No. 1, 1–11.
4 *Curr. Sci.*, 1937, **5**, No. 11, 590.
5 *Ibid.*, 1938, **6**, No. 11, 556–57.
6 *Proc., Ind. Acad. Sci.*, 1938, **7**, No. IV, 161–76.
7 Snowden, J. D., *The Cultivated Races of Sorghum*, 1936.

The Double Structure of Chromosomes.

The controversial matter of the structure of chromosomes has recently been revived by the note of Prof. Gates (1937)[1] and the reply thereto of Dr. Darlington (1938).[2] The vast majority of the plants investigated so far in respect of chromosome structure belong to the monocotyledons, ostensibly because of the favourable size of the chromosomes, which is an undoubted advantage and a requisite for such a study.

We found on hand a very favourable dicotyledonous material in *Naravelia zylanica* DC. The accompanying photomicrographs are from acetocarmine preparations of root-tip smears without any pre-treatment. The spirality of the chromonemata is unmistakably evident (Fig. 1), and two of the chromosomes which are especially under focus reveal

Fig. 1.

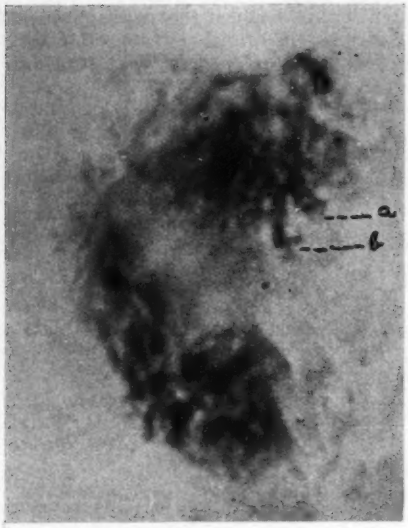


Fig. 2.

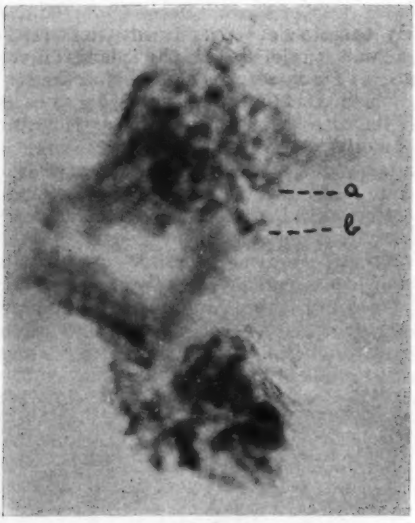


Fig. 3.

their duality in such a manner as to leave no doubt whatsoever. One of them (*b*) shows its free end diagrammatically dual and in the other (*a*) the diamond areas (Koshy, 1937)[3] corresponding to the alveoles of Grégoire (1906)[4] could clearly be recognised to be the translucent spaces between two intertwined chromonemata. This particular chromosome is photographed under two slightly different focusses (Figs. 2 and 3) so as to bring out this intertwining as also its duality at its free end (Fig. 3 at *a*).

It appears to us that Darlington's method of disposing of this duality as an artefact is untenable in the face of overwhelming evidence adduced by direct observation. If acetic acid is responsible for this artefact then it must be regarded as a characteristic artefact just as other accepted things are. And almost all the fixatives of modern cytology contain glacial acetic acid as an important constituent. If the action of such fixatives could be depended upon for all other conclusions that cytologists generally draw, there is no reason why it should be invalidated only in respect of chromosome structure. The reason why in paraffin sections this duality is not so clear is obviously due to the chromosomes not directly coming into contact with the fixative and however small and thin we may slice the root-tips, fixation cannot be as complete and efficient as in the case of a smear.

Incidentally the chromosome number of this species, which has not to our knowledge been so far recorded, is $2n = 16$.

T. S. Raghavan.
K. R. Venkatasubban.

Botanical Laboratory,
Annamalai University,
March 31, 1938.

[1] Gates, R. R., *Nature*, 1937, **140**, 1013.
[2] Darlington, C. D., *ibid.*, 1938, **141**, 371.
[3] Koshy, T. K., *Ann. Bot. New. Ser.*, 1937, **1**, 43.
[4] Grégoire, *La Cell.*, 1906, **23**, 311.

Yellow Rain.

Early in March last Gurdaspur experienced a very slow precipitation of rain drops which continued for a few days. According to Mr. S. A. Efzelle, M.A., B.Sc., 15 drops of rain fell per square foot in 24 hours. These drops left bright yellow marks on drying. Mr. Efzelle sent me a little of the yellow powder left on drying of these rain drops on a piece of paper. I examined this powder which consisted mainly of pollen grains of three different types, namely: (1) one furrowed ones, (2) smooth single-pored globular grains, and (3) some triangular ones. The first two types predominated. The first type seems to me to be pollen grains of some Conifer and the second of some grass. First week of March is rather too early for

the male flowers of Conifers to ripen in the lower hills of the Punjab. Attempts are being made to determine specifically the different types of pollen grains and a further communication will be made later.

H. CHAUDHURI.

Department of Botany,
Punjab University,
Lahore,
June 1, 1938.

Investigations on Rice.

PROF. SANJIVA RAO'S recent note[1] on the above subject has inspired me to give a brief account of some of our findings on allied lines of work, which are now awaiting publication.

The nature of parboiling has been studied from an examination of the attendant changes in the different constituents of the rice grain as a result of polishing to varying degrees. Parboiling results in a partial gelatinisation of the starch in the superficial layers of the endosperm; in some cases, the gelatinisation extends well into the interior. There is evidence[2] to suggest that the constituents originally present in the aleurone layers of the raw rice move in part into the interior towards the endosperm. The extent to which parboiling preserves the vitamin B_1[3] and, together with it, the essential nutritive constituents of rice on polishing, would depend on the variety of rice and in particular, on the thickness of its bran layer and the extent of parboiling.

The colour of parboiled rice may be improved considerably by reducing the time of steeping and shortening the period of parboiling. Indeed, very recently, a process has been patented[4] according to which, a light coloured product can be obtained by heating rice or paddy (previously steeped in water) for very short periods at over 400° C. The use of chemicals like acid sulphites,[5] peroxides, persulphates and certain carbonates in the steep water in small amounts also lightens considerably the colour of the grain on parboiling.

The changes during storage have been studied by me by following the volume expansion on cooking of rice obtained from paddy immediately after harvest and after different periods of storage (*a*) in loose gunny bags, (*b*) in bottles loosely plugged with cotton wool and kept (1) at room temperature, and (2) at 0° C. in the ice chest, (*c*) in tightly stoppered bottles and (*d*) in sealed flasks (i) anaerobically and (ii) in presence of carbon dioxide gas. The results have shown that the rate of improvement in cooking quality is greatest in samples stored in air-tight containers or under anaerobic conditions. Paddy stored in cold chambers does not improve in cooking quality even at the end of 8 months. Well-stored rice grain swells on cooking to more than four times the original volume while the unstored grain scarcely swells to twice the original volume.

In vitro experiments on the digestibility of starch in rice with taka-diastase and pancreatic and salivary amylases have shown that when cooked, fresh unstored rice does not digest even half as much as well-stored cooked rice. This is mainly due to the fact that the properly swollen grains are better penetrated by the digestive ferments than those which are not.[6] They also present a greater reactive surface so that the digestion proceeds very rapidly. The greater ease of digestion of starch from rice on storage may also be due to amylo-hydrolytic enzyme action during this period.[7]

Attempt is being made to study the nature of the biochemical changes undergone by the rice grain during storage; there is no doubt that one at least of the factors responsible for the unstored rice cooking to a pasty consistency is the presence in the grain immediately after harvest of a fairly active α-amylase which, during storage, passes into a dormant condition.[8]

The deterioration, as a result of storage, of shelled, unpolished rice, has been found to be mainly due to the changes in the composition of the rice oil. When bran is stored for a time, there is found a rapid increase in the free fatty acids and in the peroxides, while there is a decrease in unsaturated acids. The increased rancidity on storage may in part at least be due to oxidation changes as a result of exposure to the atmosphere, while the increase in acid number is caused by the action of the lipase which is known to be present in the bran.[9] Rice polishings, originally heated for a few hours, in a current of air at 60° C., do not undergo any appreciable deterioration on storage.

Polishing results in removal of a major part of the rice fat and of the fat-splitting enzyme. Hence, polished rice has a much better keeping quality. Parboiling would appear to result in a change (possibly

polymerisation) in the composition of the fat. The process also inactivates the lipase, so that parboiled rice generally has better keeping quality even when unpolished.

Further work on the nature of the deteriorative changes and the factors contributing to improved keeping quality of shelled, unpolished rice is under study. It has been shown that desiccation combined with air-tight packing, can successfully be employed for the preservation of unpolished rice or rice bran provided freedom from insect attack is ensured. Among the different varieties examined, I have observed that certain varieties of coloured rice do not generally deteriorate in the unpolished condition as rapidly as the other varieties do. In this connection, it is interesting to note that carotenoid and other plant pigments have been known to act as powerful anti-oxidants.

My thanks are due to Messrs. V. Sadasivan, K. V. Giri and H. P. Das Gupta for collaboration in some of the above researches.

A. Sreenivasan.

Department of Biochemistry,
Indian Institute of Science,
Bangalore,
March 31, 1938.

[1] *Curr. Sci.*, 1938, **6**, 446.

[2] Sreenivasan, A., and Das Gupta, H. P., *Ibid.*, 1936, **5**, 75.

[3] Douglas, C. E., *Emp. Mark. Bd. Rept.*, 32, 1930. Aykroyd, W. R., *Jour. Hyg.*, 1932, **32**, 184. Ghosh, S., and Dutt, A., *Ind. Jour. Med. Res.*, 1933, 20, 863. Acton, H. W., Ghosh, S., and Dutt, A., *Ibid.*, 1933, 21, 103. Codd, L. E. W., and Peterkin, E. M., *Brit. Guiana Dept. of Agric. Rice Bull.*, 1933, No. 1.

[4] Ind. Patent No. 22025 dated 2nd July 1936.

[5] Charlton, J., *Agri. Res. Inst., Pusa, Bull.* 1923, No. 146.

[6] *Cf.* also Rami Reddy, K., and Subrahmanyan, V., *Trans. National Inst. Sci.*, 1937, 1, No. 11.

[7] Sahasrabuddhe, D. L., and Kibe, M. M., *Ind. Jour. Agric.*, 1935, **5**, 12.

[8] Giri, K. V., and Sreenivasan, A., *Nature*, 1936, **138**, 406; also *Biochem. Zeit.*, 1937, **289**, 155.

[9] Browne, C. A., *J.A.C.S.*, 1903, **25**, 948. West, A. P., and Cruz, A. O., *Phil. Jour. Sci.*, 1933, **52**, 1.

ACTIVATED CARBON.

Activated Carbon from Bagasse.

Activated carbons apart from their use for gas absorption are also extensively used in diverse industries for decolourisation purposes. Although animal charcoal was being mostly used for these purposes only a few years ago, the vegetable activated carbons have now been successfully replacing the same in most cases. In spite of the poor regenerative capacities of most of the vegetable carbons they have been employed either on account of their better efficiency or for sentimental reasons.

Attempts are being made in several places in India to prepare activated carbons from different raw materials of Indian origin so as to supply the increasing needs of this commodity in different industries. Several methods have been tried before in this connection for making carbons from bagasse—a bye-product of the sugar industry—but mostly without any marked success. Utilising the same raw material, a highly activated form of carbon has now been obtained by the authors. This carbon has been found to be superior to all the imported carbons on the market, particularly so far as its use in the sugar and gur industries is concerned.

The carbon is made by treating bagasse with zinc chloride solutions of suitable strength and heating the mixture to suitable temperatures to obtain finally a highly gelatinous dark-looking mass. The mass after being heated nearly to dryness at the lowest possible temperature is put into a suitable ignition furnace and heated to a definite temperature. It must be remarked that the activity of the final carbon depends to a large extent on the carefulness with which the temperature is controlled at the optimum value. When the evolution of steam and other vapours have stopped issuing out completely and after maintaining the temperature of the furnace at the optimum value for about half to one hour, the mass is allowed to cool and, after crushing the same suitably, is treated with hydrochloric acid solutions. The carbon is filtered off from the solution and washed with water till the wash liquid is well free from acid. The carbon mass is dried suitably and is then ready for use.

Almost the whole of the zinc chloride used in the process is recovered and is used over and over again. Attempts are also being made to recover the hydrochloric acid in a suitable form to reduce the cost of manufacture still further.

Although zinc chloride has been used before for making several types of activated carbons in other countries, the processes have been kept absolutely secret and the details of the same are not available to the public. The authors have here worked out a method in detail for making a highly activated carbon from bagasse and utilising zinc chloride so as to be able to meet the demands of Indian consumers.

Further experiments are also in progress regarding the utilisation of many other raw materials as well as activating agents for making activated carbons still better and cheaper utilising the method described in this paper.

Preliminary calculations have shown that this carbon is cheaper than the imported ones.

Further details of the method and of the equipment necessary for a large-scale plant will be published elsewhere. An application for securing the patent rights for the above process and plant has already been submitted.

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S. N. Gundu Rao.

Imperial Institute of
Sugar Technology,
Cawnpore,
May 5, 1938.

Activated Carbon from Paddy Husk.

Within the last few years quite a few articles have appeared in Indian Journals, describing methods for the preparation of activated carbon. The need for a cheap production of a highly active carbon for various industrial and agricultural purposes requires no emphasis and accordingly work was undertaken by the authors early during this year. As a result of a series of prolonged trials, the following method was arrived at and found to be the most satisfactory. Government are being approached for patent rights which it is hoped will be granted early.

Paddy husk is treated with a solution of zinc chloride and allowed to stand overnight when it swells and becomes brown in colour. The mass is then digested under pressure when the husk becomes charred and carbonises. The wet mass is then evaporated almost to dryness and filled into activating tubes and heated. After all the steam and other gases have stopped issuing, the tube is made air-tight and raised to optimum temperature where it is maintained for a few hours. The mass is then allowed to cool out of contact with air, broken, and the zinc chloride extracted from it by boiling with dilute solution of hydrochloric acid and filtering (zinc chloride can be easily recovered from the filtrate). The mass is then washed free from chloride, dried, ground to required fineness and dried again.

The cost of production of this carbon is comparatively low and large-scale production is already under way. From an examination of the carbon by means of standard methods such as the determination of the molasses and permanganate numbers, etc., it appears to belong to the carboraffin group. It may be added that the carbon has been used with much success for large-scale production of cream jaggery.

It is hoped in the very near future to extend the use of this carbon to other industrial purposes such as refining of oils, etc., on which experiments are progressing. It is to be stated that cheap raw materials like casuarina needles, etc., are being exploited for the preparation of active carbon. A detailed account of this investigation will appear in due course.

N. G. Chokkanna.
B. T. Narayanan.

Chemical Laboratories,
Department of Agriculture,
Bangalore,
June 3, 1938.

REVIEWS.

Civilization and Disease. By C. P. Donnison with an Introduction by Sir Walter Langdon-Brown. (Bailliere, Tindall and Cox, London), 1937. Pp. xv + 222. Price 10*sh.* 6*d.*

The progress of civilisation has brought in its wake evils and diseases from some of which the primitive tribes seem to be exempt. Dr. Donnison has had exceptional opportunities for studying the health problems of primitive groups of people during his service as Medical Officer in charge of a native reserve in Central Africa, and also those of the more sophisticated civilised people in England. The knowledge which he brings to bear on the topics discussed in the book in many respects is as intimate as his experience is varied. "His investigation brings out the close ætiological relationship that exists between hyperpiesia, diabetes, Graves's disease and peptic ulcer, a relationship that becomes apparent when they are studied as products of environmental change, but which is overlooked when diseases are classified and studied in relation to anatomical and physiological systems." The book is indispensable to the medical profession, and even the intelligent layman who takes interest in problems of general welfare of the public will find the book interesting, offering helpful guidance in understanding the effects of the severe strain of modern civilization on the mind and body of men and women who come most under its influence. The principal interest of the book for the medical men lies in the exposition of the psycho-somatic principle of the individual which is receiving increasing attention in the study of modern diseases. The author after a short review of the theories expounded by different schools of psychology, declares himself in favour of the Adlerian view-point, which he considers "as based on a biological outlook of a much sounder nature than the others".

The first six chapters are devoted to the consideration of the evidence for the ætiological association of civilization with specific diseases and although it is apparent that an association of such an intimate nature can hardly be presumed to emerge from any investigation into the statistical or other data, the author has framed a series of criteria which could profitably be employed as the bases of future study. These criteria are: (1) "That the disease concerned is common in white races in Europe, North America and in other parts of the world to which Western civilization has spread. (2) That the disease concerned is also common in members of such cultures resident in the countries occupied by primitive races. (3) That the disease is non-existent, very rare or relatively very much rarer in primitive cultures which have undergone little change for a large number of generations. (4) That as Western civilization increases its influence upon a culture by colonisation, education and urbanization, so the incidence of the disease shows a tendency to increase. (5) That a primitive race that by force of circumstances lives under the influence of Western civilization shows an incidence of the disease closely comparable with the culture with which it is associated."

Using these criteria as a working basis, the author critically examines the ethnology of disease, ætiology, the influences of civilization, the psychogenesis of the kinetic diseases and the ætiology of the psychoneuroses. A survey of the incidence of diseases in different races has led the author to establish a close relationship of certain diseases with civilization and he gives a list of other diseases which show some relationship with civilization. The biological factors which underlie civilized life, and which seem to exert an influence on this relationship are: (1) "disorders of a psychogenic nature exerting an influence through centres in the hypothalmic region and the related endocrine and autonomic nervous systems, (2) a change in relation to food supply an increased accessibility predisposing to overnutrition, and (3) an alteration in the nature of response to psychological stimuli under civilized conditions in which reactions which are produced as a preparation for physical exertion fail to find their appropriate outlet".

The chapter on the theories of origin of civilization is fascinating. The author does not accept the explanations of Freud and Unwin but inclines to the view that the basis of cultural development was the

environmental factors and psychological readjustment. Generally speaking psychologists and anthropologists are fond of investing simple facts with philosophical and abstruse explanations, but the author while condemning this tendency, is not wholly exempt from the fault himself. But perhaps big ideas require involved language for their expression.

We have no hesitation in thinking that this book will be welcomed by the medical profession and read by all with pleasure and profit.

Science and Social Welfare in the Age of Newton. By G. N. Clark. (The Clarendon Press, Oxford), 1937. Pp. 159. Price 6*sh.* net.

This is a delightful little book, consisting of four lectures which the author delivered in the University of London in Lent Term, 1936, and it is needless to say that every chapter bears the stamp of high scholarship and research for which Prof. Clark is distinguished. It is difficult to conceive of any scientist interested in the applications of science to technology, who will not find satisfaction in the exposition of the theme "about the place of science in civilization". Scientific inventions and discoveries have helped the expansion of industry and transport and material progress has brought in a crop of social and political evils. Has science still the power of controlling or eliminating these evils from public life? The author sets out to examine the numerous problems which the development of scientific research has produced, tracing their history from the period when Western civilization was definitely growing towards modern conditions. This period in the history of scientific thought is the Age of Newton. The influence of scientific investigations on the growth of economic life was already felt, and the co-operation of science and industries, begun in the late seventeenth century, laid the foundation of the greatness and achievements of the twentieth.

The first lecture is devoted to the consideration of the spirit underlying the foundation of the Royal Society and the *Academie des Sciences* which aimed at the close co-operation of science and technology. During the Dutch War, the technological and allied work suffered a check on account of the public calamities absorbing the energies of those Fellows who had been most enthusiastic for such work. Industrial work of the Society never regained the level it had attained in the earlier years, but the foundation was laid both by the British and French Societies for the improvement of technology by bringing science into close co-operation, with the result that in modern times, an indissoluble connection is established. But the problems of civilization extend beyond the improvement in industry and transport, and the influence of science is brought to bear on social, economic and political questions in a way not witnessed in the past. In the subsequent chapters the author examines the possible and probable directions in which the current movement of integrating science with society is likely to tend, either to the prejudice or to the profit of humanity. The problems arising from such integration are treated with a broad outlook and incisive analysis, and it is difficult to imagine if any student of social science or any statesman directing the destiny of a country could fail to find ample satisfaction in the perusal of the scholarly exposition of the intensely human problems, so varied and complex, and yet so vividly and charmingly portrayed in the book.

The Handmaiden of the Sciences. By Eric Temple Bell. (Bailliere, Tindall & Cox, London), 1937. Pp. viii + 216. Price 9/-

Those who have read Professor Eric Temple Bell's previous works will welcome this charming book which in point of lucidity of expression, brilliant style and quaint humour, maintains the usual high standard. *The Queen of the Sciences* of which the present book is perhaps a supplement, sets forth the nature of mathematics, whose uses and applications form the main theme of *The Handmaiden of the Sciences*. It is customary for Professor Bell in works of this kind to premise that for a proper appreciation of the treatment of the subject, he does not presume on the part of the reader a deeper knowledge of mathematics than is comprehended by the high school course, but virtually he presupposes a wider acquaintance. He suggests that where such readers may encounter higher mathematics they should skip over, which would not involve any want of appreciation of the book.

While it is true that where a rigorously exact form of expression is required or

where a number of closely allied facts could be comprehended under one general formula, mathematics must be indispensable, still the theory that with its aid, knowledge must remain empirical or that it cannot progress, may not be true. There must necessarily be two extreme views, *viz.*, that the use of mathematics in the investigation of nature is a nuisance and that without creative imagination inspired by mathematics, knowledge can only blunder through the senses: and between such views must lie "the level road of well-attested historical fact".

The thirteen chapters included in this book deal with the historical development of mathematical knowledge and the nature and extent of the application of such knowledge to the progress of investigations in other fields; and those who have read the author's work on "The Men of Mathematics" will find that practically all aspects of the subjects have been described in the life-histories of their originators. The book under review may not contain anything which its author has not already said before, but the chief merit of the book nevertheless lies in the fact, that it marshals "the services which mathematics has rendered to the sciences", under attractive captions and in a delightfully readable presentation. The book may not add greatly to the reputation of the author, but it certainly lays the reader under a great obligation to him.

Isaac Newton, 1642–1727. By J. W. N. Sullivan, with a Memoir of the Author by Charles Singer. (Macmillan & Co., Ltd., London), 1938. Pp. xx + 275. Price 8/6 net.

"At this period of his life (1724) Newton's conviction that Science was relatively unimportant seems to have deepened and strengthened," and the famous remark that he made just before his death about the ocean of truth and his picking shells and pebbles, "is only a way of saying that science, as a way of reaching what he calls truth, is incompetent and a life devoted to it largely wasted. Probably he felt that his researches even on the chronology of the ancient kings of Israel were altogether more valuable, although he may have doubted whether they were so successful". These sentiments may appear unique in Newton who, during his life time and for two centuries after that, was regarded as the "Legislator of the Universe".

The book explains this apparent anomaly and Newton himself was conscious of the divergence of the natural inclinations of his temperament and those of his intellect. Of the numerous works of Sullivan in fiction, music and science, perhaps his Newton will always remain as the most outstanding. Sullivan had spent nearly ten years in collecting material and in the composition of this book which unfortunately owing to his death in 1937, he could not see through the press. Professor Singer to whom this task was entrusted has added a memoir of the author. If an Index had been supplied, the readers would greatly appreciate the usefulness of this part of the book, in addition to the general excellence of the main text.

It may be that this book does not reveal any fresh facts about the life and achievements of the great man whose concepts and outlook exercised a most profound influence on contemporary scientific and mathematical thought, and which, during the period of subsequent developments, continued to be regarded more or less in the nature of a cult. But nevertheless the book represents the most interesting summary of the public events and episodes in the life of Newton, and the author has painted them with the critical insight of a discriminating scientist. Both in style and choice of the matter the book is a worthy contribution and we have read it from cover to cover with the avidity with which a modern student reads a detective story. The eight chapters of the book have no heading, but the deligent reader will have no difficulty in suggesting suitable titles.

Practically, the whole book is occupied with the polemical relations of Newton with his contemporaries, both in England and abroad, and the controversies, in which he was involved illustrate that he had his own share of human weakness. The numerous letters which form the greater part of the book will have interest to students investigating the nature and cause of disputes between Newton, Hooke, Halley, Flamsteed, Leibnitz and Bernoulli. They regarded Newton as rival and Newton regarded them as nuisance. These controversies and epistolatory correspondence have an academic importance to students pursuing the history of mathematical

researches, but to the general reader, the human side of Newton's life and character must have greater appeal. But he seems to have been endowed with poor social gifts, and his disposition partook the character of a brooding mystic. Sullivan has, however, given a short account of the relations between Cathorine Barton and Charles Montague, which forms perhaps the only family interlude in an otherwise severely scientific account of Newton's work and his relations with his contemporaries.

This book is primarily intended for the general reader who will derive a wealth of information and unbounded interest from its perusal. But we strongly feel that its usefulness for students in the Universities will be recognised by the authorities who by prescribing it as an additional text-book, will help to liberalise the minds of young men. The greatest recommendation is the author's simple and clear diction, careful selection of material and a vivid portrayal of character.

X-Rays in Mineralogy. The Atomic Structure of Minerals. By W. L. Bragg. (The George Fisher Baker Non-Resident Lectureship in Chemistry at Cornell University, 1934.) London: Humphrey Milford, Oxford University Press, 1937. Pp. 292 144 Figs. Size 15 cm. × 23 cm. Price 18/.

Since the substance of the lectures given was already contained in the first volume of *The Crystalline State* written by the author, the publication of these, as such, would have been a repetition of this volume. The author, therefore, happily availed himself of the opportunity to review the investigation of the atomic structure of minerals by X-rays. Only a brief account of this subject had been possible in the first volume of *The Crystalline State* for obvious reasons. Moreover, the book under review contains the work done in the field up to the end of 1936. Although the X-ray crystallographic data of the minerals considered are now available in Ewald's *Strukturbericht*, a book entirely devoted to minerals revealing how the knowledge of the atomic structure affords a scientific basis for classification while leading to a deeper understanding of their properties is quite welcome, especially as it comes from the pen of so eminent an investigator as W. L. Bragg.

Mineralogy, concerned as it is with the description and classification of the minerals, has been a science based on the study of the morphology of crystals, their optical characteristics and chemical constitution. In fact, to a very great extent, crystallography has been developed at the hands of mineralogists since in their conclusions they were largely guided by crystallographic data. But with the advent of X-ray analysis the position has altered considerably. Now the mineralogists have to depend on physicists for a knowledge of the atomic structure which is certainly more fundamental than the morphology and the optical behaviour of the minerals. It may fairly be claimed that the X-ray analysis of minerals is creating a newer mineralogy based on a more satisfactory foundation, *i.e.*, their atomic structure. It is of particular interest to the physicist that besides affording a scientific basis of classification, a knowledge of the atomic structure also leads to a deeper insight into the physical properties of minerals. The present volume summarises what has already been achieved in this direction. A good deal, however, remains to be done as pointed out by the author, and many fascinating points still await investigation.

Although some of the first crystals to be studied by means of X-rays were minerals, *e.g.*, rocksalt, diamond, flourspar, pyrites and calcite, it is interesting that significant work in the field has been done only in recent years. The X-ray analysis of the silicates, for instance, could not be taken up earlier owing to the complicated character of the problem and the lack of general guiding principles which since then have been elucidated by L. Pauling and W. L. Bragg.

The book is divided into two parts. Part I consists of three chapters, the first one being devoted to a concise account of some elementary facts of X-ray crystallography. The methods of crystal analysis are summarised in the second chapter while the final one deals with the general principles of mineral structures (ionic sizes, co-ordination, isomorphous substitution in minerals, etc.). The subject proper is dealt with in Part II which naturally occupies the bulk of the volume. The first few chapters are concerned with the elements, halides,

sulphides, oxides, and the oxygen salts mostly structures of a simpler character. The rest, comprising more than half the main part, are devoted to the silicates whose structure has been to a large extent elucidated by the author and his collaborators. The classification of the silicates in groups according to the arrangement of the silicon-oxygen tetrahedra corresponds closely to the mineralogical classification. Five typical forms of silicon-oxygen groupings are enumerated, based on the different ways of linking of the tetrahedra resembling polymerisation. It has been shown that in all cases the mineralogical classification is strictly in agreement with X-ray analysis wherever physical properties rather than chemical constitution form the criterion of classification. An extremely important finding is the dual role of aluminium in the silicates. In one case it enters the structure of the tetrahedra replacing silicon and in the other it occurs in positions of six co-ordination replaceable by magnesium and iron.

The relation between the atomic structure and physical properties is brought out when considering twinning, cleavage and the refractivity of minerals. The structure of muscovite, for instance, affords a beautiful example of how the remarkable cleavage follows as a consequence of the arrangement of the linked silicon-oxygen tetrahedra in two dimensional double sheets, held together by sheets of potassium atoms. One of the striking features of the felspars is the number of ways of twinning of the crystals and this has been explained by Taylor in an interesting way by the structure. Another familiar case of twinning is that of aragonite also accounted for by the structure. In fact no analysis can be considered to be correct unless twinning and cleavage are explained satisfactorily. The pioneering work of the author on the relation between refractivity and atomic structure in the case of calcite and aragonite is also described in some detail. Unfortunately, the assumptions made in the calculations are such that the application of the method to the majority of minerals is not possible.

There are 144 figures inclusive of nine plates. These are very instructive and helpful and in many cases we are able to get a three-dimensional view of the structures. There is an appendix on the nomenclature of the space-groups, an author index and a subject index. The paper, printing and get-up are excellent.

The subject-matter is presented with the usual elegance characteristic of the writings of the author. The book is authoritative and is bound to be of great help to mineralogists in co-ordinating their knowledge of the immense variety of forms of natural minerals from the general laws of mineral structures discovered by X-ray analysis.

P. N.

The Chemistry and Technology of Rubber. Edited & compiled by Carroll C. Davis and J. T. Blake. Published under the auspices of the Rubber Division of the American Chemical Society (Reinhold Publishing Corporation, New York, Chapman & Hall, Ltd., London), 1937. Pp. 941. Price $15·00.

This book is the result of the joint efforts of thirty-nine well-known contributors under the Editorial supervision of Messrs. C. C. Davis and J. T. Blake and constitutes an important publication of the American Chemical Society's Monograph Series. It is obvious that no single author could have hoped to write such a comprehensive volume as this. The table of contents contains the following heads :—

1. Composition of Crude Rubber.
2. Physical Properties of Raw Rubbers.
3. Chemistry and Structure of Rubber Hydrocarbon.
4. Mastication and Plasticity.
5. Structure and Behaviour of Rubber in Solvents.
6. Theories and Phenomena of Vulcanization.
7. Vulcanization without Sulphur.
8. Accelerators. Their History and Use.
9. Theories of Acceleration.
10. The Physics of Vulcanized Rubber.
11. Fillers and Reinforcing Agents.
12. History and Use of Materials which Improve Aging.
13. Auto-oxidation and Deterioration by Oxygen.
14. Deterioration of Rubber by Heat, Light and Ozone.
15. The Electrical Behaviour of Rubber.
16. Properties of Latex.
17. Industrial Uses of Latex.
18. Hard Rubber (Ebonite).
19. Rubber Derivatives of Commercial Utility.

20. Synthetic and Substitute Rubbers.
21. Gutta-Percha and Balata.
22. Reclaimed Rubber.
23. Practical Compounding.
24. Physical Testing and Specifications.
25. Chemical Analysis of Rubber and Rubber Products.
26. Literature on the Chemistry of Rubber.

Each chapter is written by an expert and full references to literature are given at the end. This renders the task of the future researcher easier. Although the literature on the subject of rubber, both with respect to its chemistry and technology, is fairly vast, the various previous treatises suffer from the defect that they present a mass of disconnected facts without any critical or authoritative sifting and examination of the facts.

The present volume has succeeded to a great extent in systematising and co-ordinating the more important contributions and in discussing critically the knowledge that now exists regarding the theory and practice of rubber technology. The importance of this publication is further enhanced by the many new uses which are being discovered for rubber and by the fact that this product has influenced research not only in organic chemistry but also, perhaps to a larger extent, in physical chemistry and physics and particularly in the fascinating fields of applied colloidal chemistry. The first chapter in the book which deals with the composition of crude rubber reveals the fact that besides the hydrocarbons, fatty acids, esters and polymerisation products of some of the unsaturated hydrocarbons, rubber has been reported to have a certain amount of proteinous matter. The literature on this, however, is rather vague and disappointing. Most investigations are of an early date and very few modern workers have tackled this subject owing to the difficulties which present themselves in the isolation of the nitrogenous substances. Fortunately, it is not the composition of the proteins which is the most important factor in technical practice. The more valuable information from the technical point of view is the structural constitution of the individual substances. The consensus of opinion is that " plantation rubber must be considered as a close packing of rubber globules which are separated from each other by membranes formed for the adsorption layers probably containing some proteins, the precipitated proteins and some of the serum substances ". The observations of Stevens are in accordance with this conception. He clearly pointed out when a piece of first latex sheet swells in benzene, the protein adsorption layers burst and the rubber hydrocarbon gradually goes into solution through the holes in the adsorption layers.

" That the adsorption layer is at least partly composed of nitrogen-containing substances can be demonstrated by repeated centrifuging experiments with latex, such as were carried out at the Netherlands Government Rubber Institute (Delft). The original latex had a nitrogen content of 0·038 per cent., the primary cream, 0·13 per cent., the secondary cream, 0·13 per cent. and the tertiary cream, 0·12 per cent. If the proteins were present only in serum, repeated centrifuging with combined dilution with water would soon give a nitrogen-free cream. That the nitrogen content of the cream after repeated centrifuging remains constant is at least an indication that the adsorption layer consists partly of proteins."

The plantation rubber varies considerably in chemical composition from place to place and although controlled cultivation is likely to reduce these variations, biological factors will always be a barrier to the Utopism of a strictly uniform composition of the latex. The main interest of the physicist and the physical chemist in the subject of rubber has been inspired by the hope that they may be able to throw some light regarding its extraordinary elasticity and structure. Perhaps the most outstanding discovery which has sustained this interest in rubber research is the discovery by Katz that raw rubber when it is stretched gives an X-ray interference pattern which disappears when the rubber is in the normal condition. This discovery has led to a very careful examination of the physical properties of rubber and amongst the more important properties which have been studied may be mentioned the following :—

The Tensile Behaviour of Raw Rubber, the Rate and Protraction of Stretching, Hysteresis, Racking, the Joule Effect, the X-ray Study of Raw Rubber, the Indices of Refraction and the Double Refraction.

The purification of caotchouc and its fractionation and the various states in which rubber exists constitute examples of other investigation which have helped in a clearer understanding of the rubber constitution.

An ably written chapter is devoted to the chemistry and structure of rubber hydrocarbons. As a result of numerous investigations, the writer of this chapter concludes that the molecules of rubber hydrocarbon has the composition C_5H_8, with one double bond for every C_5H_8 group. These groups are linked together by primary valence double bonds in a regular manner in the form of long chains. However, the exact type of regularity has not been definitely established. The groups may be regular in single units, or in pairs, and still conform to the X-ray data. Whether the long chains are open or closed rings has not been proved. In general, this point is not of great significance in relation to the chemical and physical properties in view of the large molecular weight. There is evidence that the chain is of the *cis*-configuration, that is, the methylene groups attached to the carbon atoms bonded by double bonds are in the *cis*-form. The lengths of the chains vary according to viscosity data, and are very great as determined by viscosity and molecular weight data.

Of the many hypotheses for the long range extension and retraction of rubber, the one which finds the greatest favour to-day is the mechanism involving the assumption that the unstretched liquid state is a system of long chain vibrating molecules linked by thermal agitation in random distribution and that the final elongated state consists of long chain molecules orientated along parts of their length in the direction of elongation. The two phase structure theory and the theory of spiral model and folded molecules which act as springs have been abandoned. It is assumed that the weaker Van der Waals forces of the rubber molecule, compared to those of other substances of high molecular weight not possessing long-range extensibility, permit partial slipping in the initial and intermediate states of elongation, and account nicely for the stiffening in the later stages of elongation, as the full intermolecular friction of parallel molecules is brought into play.

The fourth chapter deals with mastication and plasticity of rubber which are of fundamental importance in rubber industry particularly in the processes of the mixing of rubber with compounding ingredients and of sheeting and extruding compounded rubber to exact dimensions.

Very good account of the structure and behaviour of rubber in solvents has been contributed by F. W. Busse. This subject is of particular interest as the gel structure developed, when rubber is exposed to the action of these solvents, imparts valuable information regarding the structure of the latex itself.

The reviewer feels happy that the theoretical side of the chemistry of rubber has not been treated in a step-motherly fashion, which is the usual practice of writers of monographs of this type. Nor is the book of lesser interest from the point of view of the orthodox rubber technologists. The reviewer could not discover any process of technical importance which may be considered to have been ignored in the text. Such practical matters as vulcanization, fillers, accelerators and retarders are fully dealt with and a very comprehensive account of the industrial uses of latex is included in the contents.

The numerous uses of rubber have put this material high in the list of things of national importance and countries like Germany, Italy and America, which do not possess rubber plantations have worked hard to manufacture substances which are classified under the head synthetic and substitute rubbers. The success of these preparations is assured because it has been possible to introduce in them properties lacking in the natural rubber. The extensive use of rubber goods has created a new industry namely reclamation of used rubber. It is pleasing to find a chapter on this subject. As a matter of fact there is no industrial aspect of rubber technology which is not touched upon in this volume. The reviewer firmly believes that text-books of this type have raised the standard of learning in America and earned for the American Chemical Society a leading position amongst the learned societies of the world. It is no exaggeration to say that as far as chemical engineering is concerned, America leads the world and much of this success is to be attributed to the standard publications of the American Chemical Society.

S. S. B.

Economic Botany : Text-Book of Useful Plants and Plant Products. By Albert F. Hill. (McGraw-Hill Publishing Company, Ltd., New York and London), 1937. Pp. 592. Price 24*s*.

Botany, as taught in most colleges, often means little more than a highly technical study of the families of flowering plants with little of human interest in it. An observation of floral characters and leaf forms undoubtedly leads a student towards accurate observation, but he constantly asks himself "What is the use of all this?" and does the work only because it is necessary for the inevitable aminaextoins.

In the opinion of the reviewer it is high time to revise our methods of teaching this branch of Botany. We must of course deal with the families and their important characters and tell the student to distinguish one from the other, but the flesh on these "dry bones" is to be put by telling the students the use man makes of the various plants about him and showing them pressed or preserved specimens of important plants of other countries also which are of use in daily life. Every Botanical Laboratory should have in its museum one or two showcases devoted to the exhibition of plants of economic value and each specimen should bear a concise note describing the way in which it is made use of by man.

The book under review will help the object in view and hence we welcome its appearance. It is divided into three major parts; the first dealing with industrial plants and plant products, the second with medicinal plants, and the third with plants used for food. The treatment does not have an encyclopædic completeness but it represents a fair conspectus of a vast subject and there is appended a Bibliography of 160 references for those who wish to obtain further information. There is in its pages a fund of reliable information which will be of immense value to the teacher, the student and the cultured citizen, and it should be used to supplement the usual text-books on Botany. The printing and get-up are of the usual McGraw-Hill standard and the style is entertaining.

P. MAHESWARI.

Le Baccara. By Georges Le Myre. (Hermann & Co., Paris), 1935. Pp. 204. Price 12F.

This book is concerned with a particular form of gambling, through cards. It sets forth in an easy style the principles underlying the betting, from the point of view of the Theory of Probability, and some practical rules are given.

The majority of gamblers are not mathematically minded. There may, however, be a few scientists, who, in their weaker moments, resort to gambling. The particular form of game elucidated here is probably not played in any part of India. There is no need for India to add to its miseries by learning one more form of gambling.

C. N. S.

Surface and Radiological Anatomy for Students and General Practitioners. By Arthur B. Appleton, William J. Hamilton and Ivan C. C. Tchaperoff. (W. Heffer and Sons Ltd., Cambridge), 1938. Pp. 311. Price 15*sh*. net.

To a medical student commencing the Medical course the subject of Anatomy is found to be very difficult as it is found necessary to remember a very large number of facts. One is able to appreciate Anatomy only after spending some years of study of the subject. The authors, two of whom are well-known teachers in the subject, are best fitted to write a book on Surface Anatomy, and their association with a Radiologist increases the scope and importance of the book.

In the Preface, the authors write, "We have ventured to travel beyond the usually accepted scope of works on Surface Anatomy. It has been our aim to provide an introduction to the study of features, which are accessible to examination in the living subject. To the time-honoured methods of physical examination we have added the employment of Radiology." Radiology is being made use of more and more, and it is the feature of this book that by combining surface anatomy with radiological anatomy the authors have emphasised the study of the living subject instead of only the cadaver.

After an introductory chapter the rest of the book deals with different regions of the body. In their Introduction, mention is made of individual variation which is influenced by the muscular development and the amount of fat deposited in the tissues. The presence occasionally of some abnormal muscle and extra bone is also mentioned. Emphasis is laid on employing landmarks that individuals exhibit,

habitual differences in their relative positions of various parts of the skeleton, and that the relative positions differ in the same individual in different positions. Mention is also made of 'postural tone', which is due to the discharge of impulses asynchronously, resulting in the various muscle-units being in different phases of activity. This can be understood only by students of advanced Physiology.

The other chapters deal with different regions. The muscles and other structures which can be seen and felt on the surface, are described in detail. Ossification centres are described and at the end of the book, the Appendix contains tables of ossification. There are also tables of segmental innervation of muscles of the limbs.

The book is very well illustrated and radiographs are re-produced as negatives. It should be of use to advanced students particularly to those who intend specialising in Radiology. R. N.

Outlines of Geology, being a Combination of *Outlines of Physical Geology*, by Prof. C. R. Longwell, Prof. A. Knopf and Prof. R. F. Flint, Yale University; and *Outlines of Historical Geology*, by Prof. Ch. Schuchert and Prof. C. Dunbar, Yale University. (John Wiley & Son, New York; and Chapman & Hall, London), 1937. Pp. 356 and figures 297; and pp. 241 and figures 151. Price 20*sh*.

It is with great pleasure that we welcome this book which is a condensed version of the now well-known and widely appreciated larger work on Physical Geology and Historical Geology, under the same joint authorship, first published respectively in 1932 and 1933. The aim of the authors in publishing the present volume is to present a less comprehensive and somewhat simpler treatment than in the larger work. But the general plan and organisation of the book is retained on the same broad masterly lines, with a freshness and novelty of treatment of all branches of the subject, which has made these volumes so helpful to all serious students of geology as well as to others interested in a general survey of the past history of our Earth. This aim of the authors has been amply fulfilled and the handy volume before us is sure to prove a distinct aid to the cause of geological education in the earlier, and, therefore, perhaps more difficult stages.

In comparison with the ever-increasing stream of attractively produced educational text-books and manuals in physics and chemistry, and to a less extent, in the biological sciences, geology has a scanty literature for school and college use. This is a pity, for as a subject of liberal education and culture and for cultivating in the young a love for the natural sciences and for outdoor educational pursuits, geology is an eminently suitable medium, both for the secondary schools and early stages of university instruction. This is perhaps more true for India than for Western countries, for here in our primary schools no facilities whatever exist for implanting or encouraging a desire for the study of nature out of doors. A volume like the present one under review will go a great way in supplying this need by the wealth of its illustrations, both photographic and diagrammatic, its clear, simple, yet vigorous language, from which technical terms and phrases are largely excluded, and by the selection of appropriate examples culled from the geological phenomena of the present-day world. To achieve this simplicity and brevity nothing of substance has been sacrificed. Greater emphasis is placed on enunciation of principles than on multiplicity of details and statistical facts. A minor drawback for the Indian reader may be that most of the illustrations and examples of geological phenomena are taken from America, but the results of geological investigation in other parts of the world have been given due mention, thus making the work thoroughly up to date. This is particularly apparent in the subjects of glaciation, the origin of volcanism, current ideas about earthquake motion and other movements of the earth's crust, the structure and history of mountains, land-forms, and the modern application of geophysical methods in the investigation of underground mineral resources.

But a more novel and impressive method of exposition from the point of view of the beginner or the general reader is found in the historical part of the book. The usual orthodox way of treating the subject of the past history of the Earth system by system, commencing with the earliest period to recent times, is avoided in favour of topical descriptions of a few selected periods of earth-history. Since only a few glimpses can be obtained into the grand panorama of geological history from a compendium of

this size, the authors have provided a telescope rather than a microscope so that the reader may gain some views into this vast vista of cosmic time, views that have depth and perspective rather than details. In the course of about a dozen chapters, the main features of the geological history of our Planet is illustrated, giving a broad outline of the evolution of life, the succession of prominent faunas and floras, reconstructions of some palæozoic landscapes, the recurrent cycles of geographical revolutions, past glaciations and Man's descent from primates in course of the Tertiary ages. Just enough of details is given, with liberal use of illustration, to stimulate further search for knowledge in the student, but a latent emphasis is always implied on the methods and principles on which earth-history is constructed and is to be studied. The hand of the eminent veteran geologist, Professor Charles Schuchert is discerned in this method of exposition of stratigraphic geology; it may be hoped the method be more frequently followed in our class-rooms in colleges and universities.

We can confidently recommend this volume to Indian students taking college courses in geology and advanced geography. It will also provide much fascinating and useful information to the general reader interested in Natural Sciences. D. N. W.

The Indian Zoological Memoirs—VII. *Salmacis* (The Indian Sea-Urchin). By R. Gopala Aiyar. (Lucknow Publishing House, Lucknow), 1938. Pp. 68. Price Rs. 2.

Some of the earlier memoirs of this valuable series have been reviewed in this *Journal*, and it is not necessary, therefore, to discuss the history of this series. It should suffice to note that in a country like India with a more or less distinctive fauna of its own the standard European or American text-books on Zoology dealing mainly with the European or American Types are often of little use for the study of the structures of Indian animals. Six volumes of *The Indian Zoological Memoirs* were published up to 1936, and the present one on the common Sea-Urchin—*Salmacis bicolor*, the seventh of the series, by Professor Gopala Aiyar of Madras, fully maintains the high standard of the earlier volumes.

In an introductory chapter the author gives a short account of the Echinodermata, the phylum to which the Sea-Urchin belongs, and includes brief but succinct descriptions of the families, genera and the common Indian species. Here perhaps one may be excused for making a passing reference to an omission on the part of the author to Koehler's monographic work on the Indian Echinoidea (Calcutta, 1927) in which detailed and well-illustrated accounts of the Indian forms based on the rich collections of the Indian Museum were published. This would also explain his omission of Pedinidæ from the families included under the Endocyclica or the Regular Urchins, and of *Salmacis roseo-viridis* Koehler from the list of the Indian species of the genus *Salmacis*.

The detailed descriptive account is clear and concise, and should enable anyone to follow the complicated structure of this interesting animal without any difficulty. The illustrations, a plate showing the oral and aboral views of the Urchin and 47 text-figures, which are clear and well reproduced, add greatly to the usefulness of the work. A few coloured diagrams on the model of the illustrations of *Echiurus esculentus*—Oursin Régulier—published in Cuénot's beautiful account in Boutan's *Zoologie Descriptive* (Paris, 1900) would have made the volume still more useful and we would suggest the adoption of such coloured drawings in future memoirs. The chapters on development and bionomics of the species based on the author's own investigations are of particular interest, while the detailed directions for practical work should prove useful both to teachers and students.

Finally, while congratulating the editor and the author of the volume we hope that the issue of other monographs on the common Indian animals would be accelerated, as the publication of an authoritative text-book on Indian Zoology cannot possibly be undertaken until such detailed accounts of the Indian forms are available. B. P.

Botanisches Vademucum für Bildende Künstler und Kunstgewerbler. By Prof. Dr. G. Haberlandt. (Gustav Fischer, Jena), 1936. Pp. 80. Price RM. 4·50.

This book, primarily designed to serve as a guide for painters and draughtsmen, is a small treatise on Botany, that will be of interest to all who wish to know of the beauties of plant life. Besides being an old teacher and investigator, the auther, now Professor Emeritus at Berlin, has had the

advantage and experience of much travel in foreign countries.

The greater part of the book naturally deals with the flowering plants but other groups have not been entirely ignored. Among the Algæ the author calls attention to the balls of *Nostoc*, the skeletons of Diatoms and the thallus of *Dictyota*. It is surprising that *Volvox* and *Spirogyra* have been omitted. On p. 3 there is an excellent picture of *Dictyophora* whose snow-white fruit body reaches a height of 15–20 cm. A brief reference to other Gasteromycetes, notably *Geaster*, and the lichens, is followed by about 3 pages on the mosses and ferns and lastly the flowering plants. Here we find an elementary but attractively written account of the morphology of the root, stem, leaf, flower, fruit and seed.

The printing and get-up are excellent and the book will be of use not only to the artist but also to the cultured citizen.

P. MAHESHWARI.

Modern Physics. By Dr. G. E. M. Jauncey. Second, revised and enlarged edition. (Chapman and Hall, Ltd., London), 1937. Pp. xviii + 602. Price 22 *sh.* net.

This book represents a very successful attempt to impart to students who have had one year of college training a large portion of that interesting branch of physics which goes by the characteristic name of Modern Physics. We have here Relativity (Special Theory), Photoelectric Effect, X-rays, Quantum Theory and its applications to Specific Heats and Spectra, Radioactivity and Nuclear Physics, Radio and Television, Cosmic rays, Geophysics, Astrophysics, Physics of High Pressure and some explanation of General Relativity and Quantum Mechanics and their philosophical significance. Portions of classical Physics which the student is not likely to have studied in his first year, such as wave motion, alternating currents, electrodynamics and electron theory and the kinetic theory of gases are treated in the beginning, after an interesting historical introduction and a useful chapter on the Calculus. The treatment is everywhere fresh, interesting and easy to follow. Many advanced formulæ, in alternating current theory for example are derived in a very simple way without making use of differential equations. The chapters on X-rays and cosmic rays in particular embody an admirable presentation rendered possible by thorough mastery of the subject. We can give expression to our appreciation of the book by saying that the other chapters are almost as good as those we have mentioned. There are numerous fine illustrations and some photographs of scientific celebrities add to the attraction of the book. B.Sc. pass students can get an excellent knowledge of modern physics by means of this book and Honours students will do well to study it so that the physics behind the mathematical development may be clearly grasped. We recommend it to all such students.

If we may permit ourselves to offer some suggestions regarding minor alterations in this excellent book, we should say that the verification of the results of General Relativity is not really so complete and conclusive as one might be led to think by reading this book, and the formula for the length of a moving rod according to Special Relativity is incorrectly deduced on p. 168. In this derivation x_A' and x_B' are said to be the simultaneous co-ordinates of the ends of a rod in the moving system to which the rod is attached. x_B and x_A are the co-ordinates as measured by an observer in the fixed system. In this case $x_B' - x_A'$ is the real rest-length and not the apparent length as implied in the book, while $x_B - x_A$ has no significance in the fixed system since x_B and x_A are not simultaneously measured in that system. We should, on the other hand, write $x_A' = k\ (x_A - vt)$ and $x_B' = k\ (x_B - vt)$ and hence $x_B - x_A = (x_B' - x_A')/k$. Here $x_B - x_A$ is the apparent length and $x_B' - x_A'$ is the real rest-length and thus the correct result is obtained. There are some misprints, *e.g.*, on pp. 159, 161, 167, 349, 401, 470, &c. One of these is worth quoting: on p. 314 we read "Let u, v and w be respectfully (sic) the x, y and z components of V". It is not correct to say that the principle of conservation of mass holds in Special Relativity. Descriptions of Figures 194 and 206 mention some letters not to be found in those figures. On p. 498 the twist is said to be ϑ and on p. 499 the couple due to this twist is said to be $k\phi$. Besides pointing out these minor errors, we may also suggest that some mention of the Raman effect is not out of place in a book on Modern Physics.

We cannot end better than by recommending this book to the serious attention of all students of Physics. T. S. S.

CENTENARIES

By S. R. Ranganathan, M.A., L.T., F.L.A.
(*University Librarian, Madras*)

Baldwin, Loammi (1780–1838)

LOAMMI BALDWIN, an American engineer, was born at North Woburn, Massachussets, May 16, 1780. He had his education in Westford Academy and Harvard College and graduated in 1800. As he showed early predilections for engineering, an attempt was made to apprentice him to Count Rumford. The idea was however given up, on account of the prohibitive cost and time stipulated. Hence, he took to law. Even then, his engineering propensities did not leave him. In 1802 he designed and built his town's fire-engine, with capacity to throw water to a height of seventy-five feet. This was in use for over eighty years.

Changes to Engineering

In 1807 he abandoned law for civil engineering, touring through Europe to learn the profession. Having done some casual pieces of work in Boston and Virginia, he became the Engineer of the Union Canal in 1821. This canal, from Reading to Middletown, was seventy-nine miles long and included a tunnel of 739 feet, three large dams and an artificial lake. The President of the Company took objection to the width of the canal proposed by Baldwin and so the latter had to resign. After completion of the work, however, Baldwin's original figures were found to be correct and alterations were effected at immense cost.

Other Works

The following are some of the other major works designed by Baldwin :—(1) Canal from Boston Harbour to the Hudson River (1825); (2) Railroad over the same line (1827); (3) Masonry dry docks at Charlestown and Norfolk (1833); (4) Boston Water Works (1834); (5) Brunswick Canal and Railroad (1836). Some of these were works of magnitude in his days, as there was no power-driven machinery. These achievements earned the following encomium for Baldwin: "No man so well deserves the name of Father of Civil Engineering in America".

He died June 30, 1838.

Cresson, Ezra Townsend (1838–1926)

EZRA TOWNSEND CRESSON, an American entomologist, was born at Byberry June 18, 1838. He entered the service of the Franklin Fire Insurance Company in 1869, became its Secretary in 1878 and continued in that position till his retirement in 1910. But his life interest was in entomology.

Founds a Society

In February 1859, when not yet twenty-one, he founded the first entomological society of America, along with his two friends, James Ridings and George Newmann. It was first known as the Entomological Society of Philadelphia. In 1867, its name was changed to American Entomological Society. In the earlier years, when the Society was very poor, it was the enthusiasm and industry of Cresson that pulled it through. On September 4, 1861, Cresson wrote to Baron Osten Sacken, Entomologist and Secretary of the Russian Legation at Washington, "We do our own printing, as you already know; I am the compositor and also assist in the press work, and although I have had little or no experience in setting type (I have set the type for *all* the pages of the *Proceedings* thus far), yet be assured that I will do my best to have your paper got up in as neat and scientific a style as possible".

Cresson's connection with the Society, which began in such an intimate form, was maintained throughout his life. He was editor of its *Transactions* from 1871 to 1912 and its treasurer from 1874 to 1924.

Contributions

Cresson's special field of work was in the order Hymenoptera. Between 1861 and 1882 he published sixty-six papers. The first paper which appeared in 1861 in Vol. I of the *Proceedings* of the Philadelphia Entomological Society was entitled *Catalogue of the cicindelidæ of North America*. His entomological research culminated in his *Synopsis of the families and genera of the hymenoptera of America, North of Mexico, together with a catalogue of the described species and bibliography*, which appeared

in 1887 as a supplement to the *Transactions* of the American Entomological Society. His work was summarised by himself in the *Cresson types of hymenoptera* published in 1916 as No. 1 of the *Memoirs* of the American Entomological Society.

In 1865 and 1866 Cresson was also editor of the *Practical entomologist*, the first American periodical devoted to economic entomology.

Cresson is estimated as " a man of greatest diffidence, devoid of all self-display, shrinking from notoriety of all kinds· · · ·the personification of unselfishness and of devotion to the advancement of sciences "and ever ready to help and encourage young workers.

Cresson died at Swarthmore, Pennsylvania, April 19, 1926.

Smyly, Philip Crampton (1838–1904)

PHILIP CRAMPTON SMYLY, an Irish Surgeon and Laryngologist, was born in Dublin, June 17, 1838. He belonged to a family of medical men. His father was a surgeon of good position. His grand-uncle Sir Philip Crampton was thrice President of Dublin College of Surgeons. His younger brother Sir William Josiah Smyly was an obstetrician and gynæcologist of distinction in Dublin. Philip Crampton Smyly entered Trinity College, Dublin, in 1854 and became M.B.in 1860. After study in Berlin, he became M.D. and Fellow of the Royal College of Surgeons of Ireland in 1863.

His Career

In 1861, he was appointed surgeon to the Meath Hospital, his father being one of his colleagues and his grand-uncle, a distinguished predecessor. He kept this post till his death. He was a member of the viceregal staff (1869–92); President of the Royal College of Surgeons in Ireland (1878–79); Representative of the College on the General Medical Council (1898–1900); Surgeon-in-ordinary in Ireland to Queen Victoria (1895–1901); and Honorary Surgeon to King Edward VII. He was also President of the Laryngological Association of Great Britain (1889) and of the Irish Medical Schools' and Graduates' Associations (1902). He was consulting surgeon to the Hospital for Diseases of Throat and Ear, the Children's Hospital and the Rotunda Hospital of Dublin. He was knighted in1892.

His Contributions

Smyly specialised in laryngology, a field almost untouched in his earlier days. He introduced the laryngoscope into Ireland in 1860. His observations on the use of tobacco juice as an antidote in strychnin poisoning received some notice.

Smyly died suddenly from cerebral hæmorrhage in Dublin April 8, 1904.

ASTRONOMICAL NOTES

Planets during July 1938..—Both the planets Venus and Mercury will be visible as evening stars during the month. The latter will reach greatest eastern elongation (27° 15′) on July 31. It will closely approach the first magnitude star Regulus (α Leonis) on July 26, the angular distance at the time between planet and star being less than a degree. Mars attains conjunction with the Sun on July 24 and will be invisible. Jupiter, rising about 9 p.m., is favourably situated for observation and will be a conspicuous object in the latter part of the night. So also will be Saturn which will be rising about midnight. The planet is slowly moving eastward in the constellation Piscium and on July 10 will be in quadrature with the Sun. The width of the rings is gradually increasing. Uranus is in the constellation Aries and will be visible as a morning star; on July 22 the planet will be in conjunction with the Moon. A lunar occulation of some interest that can be observed in India is that of ω' Scorpii (magnitude 4·1) which will take place at about 9 p.m. on the night of July 8.

Gale's Comet.—This periodic comet was detected on May 1 by Cunningham at Harvard. At the time of discovery, the comet was in the constellation Ophiuchus and is reported to have been a diffuse object of the tenth magnitude without central condensation or nucleus. The probable time of perihelion passage seems to be June 17 and according to the Ephemeris computed, the comet is moving southeastwards in the constellation Sagittarius and getting brighter. The last apparition of the comet was in 1927.

A Faint Star of Large Proper Motion.—A faint star (of magnitude 11·8) has been found at the Nizamiah Observatory, to have a proper motion of nearly a second and a quarter per year. It is situated in Cetus and the position for 1900 is given by R. A. $2^h\ 0^m\ 10^s$ Declination 18° 5′·4 South. The star is probably a dwarf and one of the nearest neighbours of the Sun.

T. P. B.

The Tenth International Congress of Chemistry, Rome.

PERHAPS the most important International gathering of the season was the tenth session of the Congress of Chemistry held in Rome from the 15th to 21st May. There were nearly 3,000 delegates from over 30 countries and the session was a great success.

Before passing on to a review of the proceedings, it may be useful to mention that the International Congress of Chemistry has, as its aim, the study of all scientific, technical and economic questions concerning chemistry and its relation to the various sectors of human activity. The organisation of the Congress is in charge of two committees, one for general administration and the other for drawing up and carrying out the scientific and technical programme. The sessions are held at one or the other of the International centres (generally in Europe), the headquarters shifting from time to time. The official languages of the Congress are English, French, German and Italian. The proceedings are printed in at least two of the official languages.

To give an idea of the scope of the Congress, it may be mentioned that the recent session dealt with the following eleven subjects: (1) Chemistry and scientific thought; (2) Basic chemical products; (3) Chemistry and the utilisation of the various forms of energy; (4) Chemistry and alimentation; (5) Chemistry and the house—Chemistry and clothing; (6) Chemistry and health—Chemistry and hygiene—Chemistry and beauty cure; (7) Chemistry and documentation—Chemistry and advertising—Chemistry and recreation; (8) Chemistry and agricultural production; (9) Chemistry and Industry; (10) Chemistry and transports and (11) Chemistry and defence. Each section had its own president, vice-presidents and secretary and held separate meetings for discussion of original papers. The General President of the session was Prof. N. Parravono, Italian Royal Academician and President of the International Union of Chemistry.

The proceedings began on the 15th May with the Presidential Address which was entitled 'Conquests of Chemistry' and was a review of the more important recent advances in chemistry. The sectional meetings and lectures began on the following day. Among the several addresses thus delivered, special mention may be made of the following: Prof. Walden on 'The faith of scientific chemistry'; Prof. C. N. Hinshelwood on 'Physical chemistry and modern scientific thought'; Prof. W. Swietoslawski on 'The progress and future development of heavy chemical industry'; Dr. F. Bergius on 'The chemistry of the changes during the hydrolysis of cellulosic materials'; Prof. E. Votocek on 'The synthesis of glucides both *in vitro* and in the plant; Dr. D. J. Hissink on 'Chemistry and soil'; Dr. H. Lampitt on 'The trend of food science'; Prof. H. von Euler on 'Vitamins, harmones and allied substances in nature and in the animal organ'; Prof. E. Fourneau on 'The progress of therapeutic chemistry'; Prof. A. Butenandt on 'New problems in biological chemistry'; Prof. A. Seyewtz on 'The rôle of chemistry in the progress of photography and cinematography'; Prof. S. E. Sheppard on 'Optical sensitizing of the silver halides'; Dr. Fr. ter Meer on 'The more recent developments in chemical technology; Dr. G. Egloff on 'Petroleum—its chemical and industrial significance'; Dr. M. T. Bogert on 'Chemistry in the defence of the nation'; Prof. H. Mark on 'Chemistry in the service of the country'; Prof. F. Fischer on 'Chemistry and motor industry' and Prof. A. Portevin on 'The production and utilisation of new materials in transport'.

In addition to the various addresses, there were a number of original papers which were presented under the auspices of the different sections. These were necessarily small in number, the major part of the time being devoted to discourses by specialists.

The Presidential Address was delivered in the famous Capitol. The sectional addresses were delivered in the magnificient halls of new University buildings (*Citta Universita*).

On each day of the session there was a general gathering, first from 9–11 a.m. and later from 3-30–4-30 p.m., when the sectional discourses were delivered. These were attended by *all* the delegates. The members then dispersed and proceeded to the sectional meetings which were held from 11-15 a.m. to 12-30 p.m. and 4-45–7-30 p.m. This excellent arrangement avoided clashing between the different sections and enabled the members to hear all the important addresses. This is well worth copying by the Indian Science Congress. The divergence of subjects need be no obstacle to hearing leading men of science, who can always make their

discourses somewhat popular so as to interest all sections of scientific workers. It should be mentioned that multiplicity of languages rendered it difficult for most of the delegates to follow the proceedings. It is doubtful whether there were even ten in the whole audience who could follow and speak *all* the four official languages. Most of the others could speak only one and follow one or two of the others with some difficulty. Summaries of all the discourses were, of course, available in advance, but that was hardly the same as following the full texts of the various addresses.

The language difficulty was more acutely felt at the sectional meetings. The papers were in Italian, French or English. The authors could not speak or follow any except their own languages. The result was that there was practically no discussion and all concerned were anxious to get through the formalities as quickly as possible.

The diversity of languages is a serious difficulty which must soon be remedied. The best solution will be to have only one official language but it is doubtful whether, with the present national rivalry in Europe, it will ever materialize.

Perhaps the most interesting, and in many respects, the most useful feature of the Congress was the large number of social gatherings and excursions organised by the Executive. Apart from their educative value, these gatherings helped to bring together scientists of various nationalities and to enable them to establish the necessary social contact with each other. Most of the Continental delegates had come expressly for this purpose and returned quite happy in the new acquintances they had made.

Rome is a veritable paradise for the excursionist. The city and the neighbourhood abound in ancient monuments. The numerous museums and picture galleries are filled with art treasures. Added to these, the natural beauty of the surrounding country, the olive and the chestnut covered hills, the vineyards on the slopes, the numerous little lakes and the delightful villas dotted around them keep the visitor spell-bound and even make one wonder why Nature has been so partial to one little corner of the World!

Apart from this natural advantage, modern Italy has a large volume of scientific as well as technical work to her credit. To take only one line, her chemical industries have increased enormously in recent years. Most of the country's needs are met by local manufactures. Every encouragement is given to new ventures. The country is vibrant with new life and new activity.

One of the most remarkable achievements of recent years is the reclamation of the Pontine marshes, a vast tract of land where, until a few years ago, no crops could grow and which was highly malarial. Under the inspiring leadership of the Duce, a concerted attempt was made with the result that a large part of the tract has already been reclaimed. The area is now a smiling garden and new and prosperous cities, with all modern conveniences, have sprung up where once human life was impossible!

There were only four delegates from India and, of these, three were already in Europe. It may also be mentioned that a large part of the chemical work published in India is more or less unknown to a large section of European workers (this is probably also true of other branches of science). This is largely due to the non-availability of Indian Journals for which most of the European institutions cannot afford to subscribe. The difficulty has been all the greater with the recent increase in the number of journals. This is a very serious problem and can be tackled only by the joint effort of the leading workers in the country. (The time is probably now ripe for reconsidering the possibility of amalgamating some of the learned societies in the country.)

A further point which must be seriously considered is whether at least in science, India cannot stand by herself as a nation. At the recent session, Britain had a separate delegation of her own and, with a few exceptions, the members of that group had very little contact with the Indian delegates. It may also be mentioned that a large number of British chemical and other journals were exhibited in the halls, while not a single publication from India was to be seen. This may be purely accidental, but it is, nevertheless, high time that India awakened to a realisation of the position and did something to show her individuality at least in the matter of securing some scientific recognition.

V. SUBRAHMANYAN.

Rome,
May 22, 1938.

RESEARCH ITEMS.

New Super-Novae.—F. Zwicky (*Proc. Nat. Acad.*, 1936, **22**, 459) reports the discovery of some new super-novæ from the Mount Palsmer Observatory, California. These radiate during several weeks as much energy as a whole galaxy of stars. These recent super-novæ are of special interest because of their enormous absolute magnitude (of the order of − 16) being the most luminous stars known.

Integrating Instruments.—Dr. Ing. W. Meyer zur Capellen (*Zs. f. Inst.*, March 1938, pp. 93–99) gives a detailed account of several types of these instruments, how they are made and how used. There is a beautiful collection of 8 tables.

Ramanujan's Series for Computational Work.—H. S. Uhler (*Proc. Nat. Acad. Sci.*, 1938, **24**, 23) gives formulæ for calculating log π to 215 places of decimals. He makes use of one of Ramanujan's approximate formulæ for π (*Collected Papers*, 1927, p. 35) and mentions that the noteworthy advantage of this formula is that the series that arise in the course of the calculation converge with satisfactory speed and great rapidity.

Neutrons and Mutation.—In an interesting paper entitled " The production of mutations in *Drosophila* by neutron radiation " (*Genetics*, March 1938, **23**, No. 2), M. A. Nagai and G. L. Locher describe the effects of neutron radiation on the chromosomes of the fruit-fly *Drosophila*.

Slow neutrons produce no effects; any hydrogen atoms that absorb a neutron give rise to short-wave radiation which passes out of the tissue without causing any visible change, unlike γ-rays which produce mutations. Neutrons have no effect upon C and N_2 in living tissues. Boron or Lithium present in the tissue is broken down with the liberation of α-particles and protons and these bring about mutations. Majority of neutrons pass without any effect while some that are deflected in the mass of sperm cells produce more than one mutation. Therefore, the mutations are largely dependent upon the speed of the neutrons and also the presence of H_2 or recoil atoms of other elements present in the protoplasm.

A New Method of Measuring Nuclear Magnitic Moments.—The method of Gerlach and Stern has been modified by Rabi so as to yield values of the nuclear spin and magnetic moment as has already been noticed in these columns. Now I. I. Rabi, J. R. Zacharias, S. Millman and P. Kusch (*Phys. Rev.*, 1938, **53**, 318) have devised another ingenious method for determining nuclear magnetic moments by means of a molecular beam. The method is capable of great precision and can be applied to a large number of nuclei. A beam of molecules such as LiCl traverses a magnetic field strong enough to decouple the nuclear spins from one another and also from the molecular rotation. If a small oscillating magnetic field is applied at right angles to a strong constant field, a re-orientation of the nuclear magnetic moment with respect to the constant field will take place when the frequency of the oscillating field is close to the Larmor frequency of precession of the nuclear spin moment vector. This precession frequency is given by $\nu = \mu H/hi = g\,(i)\,\mu_0\,H/h$ (1), where μ is the nuclear magnetic moment and i is the nuclear spin. In the actual experiment a beam of molecules in $a^1\Sigma$ state (and so having a zero electronic moment) is spread out by an inhomogeneous magnetic field and refocussed on to a detector by a subsequent magnetic field (see *Phys. Rev.*, 1936, **50**, 472). The reorienting field is situated between these two fields. The constant component of the reorienting field was produced by an electromagnet capable of giving 6000 gauss in a gap 6 mm. wide and 5 cm. long, while the oscillating component was produced by a radio-frequency current flowing through a coil shaped like a hairpin with its axis parallel to the direction of the molecular beam. When reorientation occurs, conditions are not suitable for the refocussing and hence the intensity recorded by the detector goes down. In the experiment, the frequency of the oscillating field was kept constant and the current in the electromagnet was varied till the onset of resonance was indicated by a minimum of intensity at the detector, the intensity increasing after this minimum was passed. Thus knowing ν and H in the above formula μ could be found when i was known. In the experiment the length of the beam was 245 cm., the first field 52 cm. long and the refocussing field 100 cm. long, so that great sensitiveness was secured. In *Phys. Rev.*, 1938, **53**, 495, the authors give the following results obtained by this method:

Nucleus	i	μ
$^{6}_{3}Li$	1	0·823 ± 0·005
$^{7}_{3}Li$	$\frac{3}{2}$	3·265 ± 0·016
$^{19}_{9}F$	$\frac{1}{2}$	2·635 ± 0·014

The ratio of the nuclear magnetic moments of $^{7}_{3}Li$ and $^{6}_{3}Li$ now comes out as 3·97 which is farther removed from Rose and Bethe's theoretical value than was the original value of Manley and Millman, *viz.*, 3·89.

T. S. S.

Recherches dans la Série de la Pyridine—Étude de quelques α-Pyridones.—There is some uncertainty as to the exact structure of that important group of compounds known as α-pyridones. Decker, the pioneer worker in the field, had postulated a carbonyl structure, while O. Fischer and Kauffmann had favoured an oxide ring structure. J. A. Gautier has sought to decide definitely between these two structures and in a recent publication (*Actualités Scientifiques*

et Industrielles, No. 556, Hermann et Cie, Paris, 1937, pp. 78; Price 18 francs) gives a detailed and clear account of his investigations in the line. He has prepared some N-β-hydroxy ethyl-α-pyridones and a few ethers of N-(hydroxy-3-propanol-2)-α-pyridones and their derivatives, and has made a comparative study of their properties. Though it has not been possible to decide definitely in favour of any one structure chemically, a study of the molecular refraction of the compounds has given support to Decker's structure. The author hopes to settle the question by a study of the Raman and absorption spectra of the compounds investigated. An account of the hydrogenation of the above pyridones with nickel catalyst to the corresponding piperidones is also given. A brief reference has been made to the physiological activity of the compounds investigated.

S. K. R.

The Manufacture of Sulphitation Sugar from Coloured Canes: 'Purple Mauritius'.—The possibility of manufacturing white sugar by sulphitation process from coloured canes especially from purple Mauritius has been investigated by Venkataramanayya (*Bulletins of Indian Industrial Research*, 1938, No. 11). Under manufacturing conditions in the sulphitation process the anthocyanin pigments associated with coloured canes escape precipitation by lime and decolourization by sulphur dioxide. This colouring matter can however be eliminated by the excessive use of lime and sulphur, or the application of an active carbon like 'norit', but these schemes are prohibitively costly.

As a result of laboratory experiments, the author finds that aluminium hydroxide completely precipitates the anthocyanin pigments. When lime and sulphur dioxide are first utilized to remove the major impurities from the juice, the quantity of aluminium hydroxide required for pigment removal alone, is small and therefore the application of alumina cream after the usual liming and sulphitation is the most economic way.

Alumina cream can be produced quite cheaply by the addition of lime to commercial potash alum and washing out all the calcium sulphate produced by the double decomposition.

Aluminium hydroxide so produced was tried on the factory scale and juices were found not to undergo appreciable chemical changes. The sugar produced was bright, lustrous and absolutely transparent and completely devoid of colouring material and colloidal particles. It is possible that the use of alumina cream renders the results of sulphitation process independent of cane variety by the complete removal of pigments as was effected in the case of 'Purple Mauritius'.

The Influence of Ultrasonic Waves on the Viscosity of Colloidal Solutions.—Freundlich and Gillings (*Trans. Faraday Soc.*, 1938, **34**, 649) have made an interesting study on the influence of ultrasonic waves on the viscosity of many colloidal solutions. In all the cases examined a reduction in the viscosity is observed and this viscosity is found to be anomalous or structural. The mechanism of the reduction of viscosity is not the same, in all cases. Collapse of cavities is found to be essential. Irradiation caused a distruction of the rod-shaped particles, disappearance of the streaming double refraction and a corresponding change in the ultramicroscopic view in cotton yellow solutions. In the sodium stirate solution, viscosity reduction was associated with the appearance of a number of rod-shaped particles and the disappearance of the background of small particles. Ultrasonics had, however, no marked effect on the structural viscosity of vanadium pentoxide and benzopurpurin solutions.

K. S. Rao.

The Ape-Man of Java.—The controversy about the Pithecanthropus problem would seem to be settled by the recent discovery in Java of additional fossil parts thought to belong to this genus, indicating that the so-called "Ape-Man" is a member of the human family. Dr. G. H. R. von Koenigswald, reported (*Carnegie Institution of Washington, News Service Bulletin*, May 15, 1938, **4**, No. 27) the discovery of a right lower jaw with four teeth at Bandoeng and later at the same site the greater part of skull and three upper teeth which he referred to Pithecanthropus. These materials were taken from the conglomerate Trinil layer of middle Pleistocene age located near the village of Solo on the Solo River in Central Java. The study of these finds has led the discoverer to establish that Pithecanthropus has less brain capacity than Sinanthropus, indicating that the former was more primitive than Peking Man, the teeth and mandible show close affinity with Heidelberg man. This would place Pithecanthropus in the line of our direct ancestors. In other words the results of investigation point to Pithecanthropus being an upper Pliocene type of man who, in the middle Pleistocene, was still living in Java as a survival.

Metamorphosis of a Haploid Salamander.—The anatomy of experimental haploids is full of interest but no higher vertebrate appears to live long enough for this study. The metamorphosis of a haploid salamander, *Triton tæniatus* has been studied by G. Frankhauser (*Journ. Morph.*, May 1938, **62**, No. 3, 393). Curiously, the metamorphosis occurred normally in this form and was practicly completed at the time of death. Every organ that normally occurs in diploid salamanders at the time of metamorphosis was present, *i.e.*, the integument, the pharyngea derivatives and the special glands like the Thymus, the Thyroid, the Harderian gland, etc. Microscopical examination showed that, the tissues of the haploid form were smaller than those of the diploid as also the cells. But the number of cells was greater. In the glands the reduced cell size was completely compensated by increase in cell number.

The Physics of Meteoric Phenomena.

By Mohd. A. R. Khan, F.R.A.S.

(Osmania University College, Hyderabad, Deccan.)

FROM time immemorial meteors have presented a puzzling problem to human enquiry. In the past, their sudden bright apparition filled the mind of pre-historic man with awe and superstition; and he associated them (as he did all other imposing manifestations of nature), with influence on his Destiny. Even after the advent of civilization, people seriously interpreted them as ominous messengers of impending evil. A single instance will suffice to show what influence they wielded on human temperament at as late a period as the last decade of the fifteenth century A.D. We read in Sir Arthur Help's *Life of Columbus* that on the 15th of September 1492, hardly a month before the discovery of San Salvador by Columbus, when his sailors saw a meteor fall from heaven they became so dispirited as to lose faith altogether in the success of their enterprise.

Early in the nineteenth century, however, careful enquiry by a renowned French Scientist, E. Biot, into the origin of meteorites paved the way for a better understanding of the nature of meteors, and soon after the discovery of the Mechanical Equivalent of Heat, it began to be assumed that the light of meteors was a phenomenon of high temperature radiation brought about by the friction of the surface of solid cosmic particles with atmospheric air, when they were diverted from their orbital paths by the Earth's gravitational pull.

A careful examination of the facts of observation showed that the above simple hypothesis led to improbable conclusions concerning the temperature of meteors, their extent of surface and the density of air in the upper regions. It is only quite recently that knowledge acquired from laboratory experiments on ionisation of gases and cathode sputtering, promises to guide us to the true understanding of the nature of meteors and their interpretation in terms of the laws of Atomic Physics. Even now it must be admitted that we are far from solving the intricacies of the problem. Edward Fath, in his recent book *Through the Telescope*, writes that "Meteorites are far more inscrutable than the smile of da Vinci's Mona Lisa". It would be no exaggeration to say that meteors are almost as mysterious in their nature and origin as the light of the fabled Will O'the Whisp!

Facts of Observation.

From systematic observations spread over a number of years and recorded under varying conditions of time and place, the total number of meteors (of all magnitudes visible to the unaided eye) is estimated at 24 millions per diem. If telescopic meteors are taken into account the number probably runs up to several millions of millions. The average meteor appears at about 100 to 110 km. altitude and disappears at 80 km., after traversing about 55 to 60 km. length of path in the earth's atmosphere. Bolides or fireballs are estimated generally to appear at about 140 km. height and to disappear at 50 km., after pursuing a course in air of some 300 to 320 km. length. Telescopic meteors have been traced up to altitudes of 500 or even 1000 km. They present a very hazy appearance as at these heights the density of air is exceedingly small.

Large meteors often flare up into "bursts" or "spindles" and are seen occasionally to divide into a number of dark or reddish fragments followed, if sufficiently low down, with loud reports and peculiar hissing noises. These solid bodies that survive the luminous career of the meteor and drop on the earth as comparatively cold objects, bearing no marks of their brief fiery existence beyond a dark glossy encrustation, are called meteorites. By far the largest number of meteors are consumed in the air and reach the surface of the earth as mere impalpable dust.

A very important feature of meteoric apparitions is the luminous trail or train that is generally seen near the end part of the visible course of some meteors. Most meteors are recognised as thin luminous lines traced along the sky, successive portions of the trace disappearing as quickly as fresh ones come into view—producing on the unaided eye the impression of a small rapidly moving object suddenly becoming incandescent in its path and quickly disappearing from sight. With some meteors the line thus traced is much broader as if the small nucleus is accompanied by a brighter envelope, which disappears as quickly as the nucleus moves forward. Rarer still, we see the luminous streak develop some little time after the nucleus had moved away or even disappeared altogether, and persist for periods varying from a fraction of a second to as much as 30 or 40 minutes. Calculation shows that the air affected by the luminous streak of a bright meteor sometimes extends to several cubic kilometres in volume, especially in case of meteors whose radiant lies on the horizon. All the same, this activity seems to be confined to the E region of the ionosphere, *i.e.*, the portion lying roughly between 100 and 80 km. altitude.

In rich meteoric showers the space immediately surrounding the radiant glows with a peculiar diffuse light, due presumably to the cumulative effect of innumerable incipient trains. Leonid meteors have been observed to leave greenish trains and perseid meteors yellowish trains. Whatever the initial colour of a nocturnal meteoric train it soon fades to white, judging especially from impressions produced on the unaided eye. It is from a careful study of the behaviour and

characteristics of these meteoric trains that the secret of meteoric luminosity is being slowly disclosed. While the researches of Harvard observers and a number of enthusiasts in different parts of the world continue to throw ever more light on many problems of Meteoric Astronomy, it must be admitted that only three papers have up till now been published in the English language that attempt to deal exclusively with the theory of meteors.

Current Views of the Light of Meteors

Lindemann and Dobson[1] seek to account for the luminosity of meteors on the assumption that the air in front of the meteor is compressed adiabatically, and, making use of thermodynamical principles, come to the conclusion that the density of the air above 60 km. height is apparently very much greater than what corresponds to an isothermal atmosphere of 220° K. and the temperature is in the neighbourhood of 300° K.

C. M. Sparrow[2] considers the idea of production of heat by the motion of a solid in a fluid as untenable in case of meteors while they are moving in the upper regions of the atmosphere, where the mean free path of the air molecules is not small compared to the dimensions of the meteor and accounts for the high temperature of the meteor as resulting from its impacts with individual air molecules, but makes certain assumptions about the composition of the higher atmosphere and the elastic nature of impacts involved that cannot be accepted.

In both these papers adequate attention is not paid to the importance of meteor trains as furnishing a clue to the solution of the problem. H. B. Maris[3] draws analogy between expulsion of high energy atoms and molecules from the surface of the fast-moving meteor when bombarded by air molecules and the evaporation of the metal of the cathode (with emission of its characteristic line spectrum) when subjected to bombardment by positive ions moving with velocities of the order of 100 km. per second in the cathode-sputtering chamber.

Following Lindemann and Dobson we may assume a typical first magnitude meteor to enter our atmosphere with a velocity of 40 km. per second and dissipate its energy in 1·5 seconds, after traversing a path of 60 kms. length. Its mass (assumed by Lindemann and Dobson to be $6{\cdot}25 \times 10^{-3}$ g.) may on more plausible grounds be taken as 0·01 g. If the meteor be supposed to consist of iron (At. wt. = 56; M.P. about 1800° K. and B.P. about 2725° K.; Sp. ht. = 0·113 per g. degree Centigrade; latent heat of fusion = 49 calories and latent heat of vaporisation 90·8 Kg. Cal./g. atom, Cal.) a little calculation will show that enormously high temperatures will result if all the kinetic energy of the meteor goes to heat it. Even if a considerable fraction of the heat is passed on to the air surrounding the meteor, the temperature will far exceed the boiling point of iron. In the face of such large and rapid transformations of energy it is reasonable to suppose that the impacts between the individual molecules of air and the meteor assume the character of explosions, each impact vaporising over 50 molecules of iron from the body of the meteor with explosive violence.

The particles thus expelled will collide with the air molecules in the neighbourhood of the meteor and ionize and excite them. As Maris writes "Less than 0·02 of the energy of the meteor will be expended directly against air-resistance, the remaining 0·98 must be spent, as suggested by Lindemann and Dobson, in ionisation and excitation impacts beyond the main mass of the meteor, which lead to radiation of light".

The energy stored in the ionised air is released in the form of visible radiation when the air molecules revert to their initial unexcited condition, thus accounting for the luminosity of the meteor and the persistence of its train for short intervals of time. This explanation agrees, at least qualitatively, with the results obtained by C. C. Trowbridge[4] in his experiments on the after-glow of nitrogen—as regards colour, rates of diffusion and mode of decay. Trowbridge's deduction from recorded observational data, that the atmospheric region to which meteor trains seen at night are usaully confined, lies between 100 and 80 km., is well attested by subsequent research—the pressures in these regions being of the same order of magnitude as in Trowbridge's experiments for after-glow.

Bursts of spindles are usually seen near the end of a meteor's visible course. They may be assumed to occur only in case of the bigger meteors that have survived dissipation of matter in their descent below 80 km. of height. The greater density of the air in these regions gives rise to the formation of a gas-cap in front of the meteor, consisting of hot air and matter ejected from the body of the meteor. As soon as this gas-cap is formed, fresh impacts between the air-molecules and the body of the meteor are prevented, and it is a significant fact that after such bursts the meteor slows down appreciably and is extinguished.

It must be admitted, however, that these explanations are more of the nature of conjectures than strict statements of well-attested facts. Until a much larger number of nocturnal meteor trains are examined telescopically and their spectra pure and simple, unmixed with those of the nucleus, are obtained and studied in detail, the problem of meteoric luminosity may be regarded as still awaiting a complete solution.

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[1] *Proc. Roy. Soc., London*, (A), 1923, **102**, 411.

[2] *Ap. Jour.*, March 1926, **63**, No. 2, 90.

[3] *Terr. Mag. and Atmos. Elect.*, Dec. 1929, **34**, No. 4, 309.

[4] *Ap. Jour.* 1907, **26**, 144.

Auriferous Tracts of Hyderabad State.

IN South India, the ancient rocks, known as the Dharwar Series, noted to be the home of gold, occur in narrow almost parallel bands with a general N.N.W. trend and recognised by MacLaren under five main runs, of which the easternmost are particularly auriferous.

Some of them are represented in the Raichur Doab of the Hyderabad State, with which other parallel bands and patches also occur. The more important of them are the Maski band, the Kushtagi band, the Raichur band, the Gadwal band, and lastly the Ginigera patch.

Of these, the Maski band and the northern portion of the Raichur band are particularly known to be auriferous.

The Maski band of auriferous Dharwara is a long narrow tapering run, essentially consisting of hornblendic and trappoid schists in the northern portions, the southern being chloritic. Numerous runs of blue quartz veins are associated which carry gold in them. This band is about 40 miles long extending from near Salgundi, north of Thungabhadra, in the south, right across the Doab, upto Gurgunta, south of the Krishna, in the north, having a width varying from about 14 miles in the north, to hardly about half a mile in the extreme south, and covering a total area of about 240 sq. miles.

This band, riddled with numerous old workings for gold, dating as far back as proto-historic times, may conveniently be divided into two zones, viz., the northern Hutti-Wondalli and the southern Maski-Udbal areas: the main old workings in the former being located at Hutti, Wondalli, Toppaldoddi and Uti and in the latter at Buddini, Maski, Togaldinne and Udbal.

The northern extension of the Maski band, north of the Krishna River, is known as the Mangalur band where old gold workings have also been noted. It is significant that this auriferous Maski band with its northern extension, the Mangalur band in the Gulbarga District, lies in the same trend with the auriferous Kolar schist belt, being also similar to it in character and composition.

The presence of numerous old gold working sites in such auriferous areas only suggests that these have been extensively worked by the ancients and all surface indications exploited. So, it seems that the only chance left for the modern prospecter is to unbottom the old workings and continue beyond the depth reached by the ancient miners, who apparently had to discontinue due to influx of water and other mining difficulties which they could not cope with.

The field has received wide attention by prospecting companies. More than 300 old gold working sites have been discovered, and the possibilities of some of them explored. Gold mining at Hutti was conducted for 16 years during which time it paid substantial dividends, but the operations had to be closed down after the Great War in 1920 before its potentialities could be fully explored.

In view of the encouraging results obtained during the revision survey and prospecting work conducted by the Hyderabad Geological Department, it is hoped that with the encouragement given by the Government, the gold fields in the Raichur Doab will soon receive the attention they deserve and will result in the revival of gold mining industry in the State.

L. S. KRISHNAMURTHY.

SCIENCE NOTES.

Discovery of a New Garnet.—Details are given of the detection of a new magnesia-iron garnet in a paper contributed by Sir Lewis Fermor recently to the *Records of the Geological Survey of India* (Vol. 73, Part I).

It was suggested by Sir Lewis Fermor in 1912 that the curious bodies known as chondrules found in so many stony meteorites must once have been garnets. The suggestion was based on an examination of the meteorite which fell at Khohar in the Banda District of the United Provinces in 1910.

Since this hypothesis was propounded in 1912, no other, says Sir Lewis Fermor, has come to notice that offers an explanation more plausible or as satisfactory and consequently it can still be regarded as suitable to explain the formation of chondrules, and therefore of chondritic meteorites. The garnet adopted for this hypothesis was one that was not introduced to science at that time, consisting as it did, of a mixture of two previously unrecognised garnet 'molecules'. One of these garnet 'molecules' has since been detected as a constituent of certain Indian garnets, and of a garnet from Glen Skiag in Scotland and named *skiagite* after the Scottish locality.

If there was any foundation to the garnet hypothesis of the origin of chondrules, it was felt that it should be possible to discover analyses of garnets that could be interpreted satisfactorily only on the assumption of the presence of another garnet molecule.

This has lately been found in an occurrence of a deep brownish red garnet from a garnet diopside nodule from the Jagersfontein diamond mine in South Africa by the late Dr. Percy A. Wagner.

Sir Lewis Fermor has named this garnet 'khoharite' after the Khohar meterorite which was the starting point of his hypothesis. It would have been named after Dr. Wagner but for the existence of another wagnerite named after an earlier Oberbergrath Wagner.

* * *

Geological Work in 1937.—The Annual Report of the Geological Survey of India for 1937 records activities in several directions ranging

from water supply till gold prospecting. Important geological information has been obtained by the Officers of the Department, who accompanied the Sino-British Boundary Commission in the Wa States and Shaksgam Expedition to the Karakoram under the leadership of Mr. E. Shipton.

At the headquarters in Calcutta re-arrangements in the laboratory were completed in order to cope to the best advantage, with the large number of enquiries received during the year. Rearrangements in the fossil galleries and other museum specimens have been carried out with a view to increasing their popular appeal. Economic enquiries were conducted on bauxite, coal, gold, iron ore, clays and building materials at several localities.

The Department's advice was sought on engineering schemes such as the preservation of Elephanta Caves, the Malakhand Hydro-electric Scheme and power for Hazara District. The large number of fossil specimens collected during the year were examined by Indian and Foreign specialists and the results of their investigations were published in *Palæontologia Indica*.

* * *

Crops without Rain.—The Imperial Council of Agricultural Research is making a series of experiments in what is called *Dry Farming*, a method which has been applied with great success in America, especially in Utah. Five stations in different parts of India have been established in different stages of experimental development under the supervision of a co-ordinating committee. The Committee has a task of standardising the methods and co-ordinating the results of all the stations.

By dry farming methods it is estimated that twice as much can be grown as by wet cultivation, without increasing the cost of production. This method requires a little more labour which is easily compatible under Indian conditions, and demands conservation and proper utilisation of subsoil moisture. Among other items of investigation, mention may be made of soil survey studies in plant physiology, preservation of water under different conditions and the effects of deep and shallow cultivation on the absorption of rain water, inter-culture of crops, the value of bunds in conserving rain water, the effects of varying the seed rate and farmyard manure and different rotation of soil moisture and crop yield.

These dry farming experiments have now reached the third year of the five-year programme and results obtained so far are promising.

* * *

Temporary Seismic Equilibrium in Northern India.—In the year 1937 Burma and Northern India experienced earthquakes and it has been reported that there were 82 shocks in all, of which North-Eastern India and Burma received the largest number and North-West India was not spared. In peninsular India the number was negligible.

Dr. Coulson in an article contributed by him to the *Records of the Geological Survey of India*, 73, Part I, has reached the conclusion that the region between the North-West Himalayas and the Hindukush has attained a temporary equilibrium. According to him the observers' reports indicate that the epicentral region of the severe shock which occurred on Sunday, 14th November 1937, was in the Hindukush Mountain near Drosh in Chitral. The instrumental records of the shock received from Agra, Kodaikanal, Kolaba and Alipore, indicate that the shock had a very deep focal depth of 200–240 kilometres. This is in agreement with and confirms the views of Dr. Coulson regarding the shock of the 1st February 1929, in the North-West Himalayas.

After a critical investigation, Dr. Coulson thinks that the shocks in North-Western and North-Eastern India must have had different epicentres and the temporary equilibrium after the earthquake of the 14th September 1937 will lost till the accumulated stresses are again relieved, either by a sudden shock or by a shock heralded by a succession of four shocks.

* * *

Saving Wastage of 60,000 Bales of Cotton.—Anything up to 60,000 bales or 10,000 tons of cotton are, it is believed, largely wasted in this country in the form of cotton linters.

Cotton linters are the short fibres left when the cotton is ginned with a saw gin. They are ¼ of an inch and are nearly always allowed to go to waste. In roller ginning these linters are mixed up with cotton and sent to the mills. When this cotton is spun they fall out and are again wasted.

The Indian Central Cotton Committee has been carrying on experiments in the first stage of artificial silk production by the *acetate process* and is determining the cost of producing chemical cotton, *i.e.*, purified cellulose made from cotton. The experiments are carried on at the Cotton Committee's Technological Laboratory in Bombay. Given the cost of production of the basic material, chemical cotton, an industrialist can calculate the cost of rayon manufacture.

The other basic material used in the production of artificial silk is acetic acid. Experiments are being carried out at the Imperial Institute of Sugar Technology in Cawnpore which is studying the cost of production of acetic acid and acetic hydride from molasses of which there is an abundant supply in India.

Both cotton linters and molasses are materials that are available in this country and their use would be a valuable addition to the country's wealth.

* * *

The Corrosion of Tar Stills.—The Department of Scientific and Industrial Research has pointed out ("Chemistry Research Special Report" No. 4, H.M. Stationery Office, 9*d*. net) that decomposition of ammonium salts present in the aqueous liquor normally associated with tar was responsible to some extent for the corrosion of stills, but it was also agreed that some organic constituent or group of constituents in vertical retort tars was mainly responsible for the damage. Accordingly, the objectives of the investigation were :

(i) to identify the compounds or groups of compounds responsible for corrosion; (ii) to devise methods for the removal of such compounds or for the inhibition of their harmful action; (iii) alternatively, to discover a metal or alloy which would resist attack or to develop a protective coating for the mild steel in general use as constructional meterial for tar stills.

After an exhaustive examination of a long series of tar fractions, the following conclusions were reached:—The corrosive effect of neutral and basic constituents was negligible but at high temperatures, resinols or petroleum insoluble phenols were very active in promoting corrosion, and in the presence of ammonium chloride the activity of these materials was intensified. The more volatile phenols were not corrosive, a fact which is confirmed in industrial practice where tar acid stills have a very long life. Resinols are defined as those non-crystalline portions of tar soluble in caustic soda and precipitated from solution in an organic solvent by addition of light petroleum. In a crude form they are isolated as a viscous pitch but they can be purified to the condition of a brown amorphous powder. Low temperature tars are particularly rich in resinols, whereas coke oven and horizontal retort tars are almost devoid of such components. Vertical retort tars occupy an intermediate position with respect to this content of resinols. Further examination of the whole range of resinols revealed the fact that the portion soluble in benzene was much more corrosive than the insoluble part, probably owing to the circumstance that the latter, being highly polymerised, is almost inert. Confirmation of the conclusion that the corrosive effect of any tar is dependent chiefly on the content of benzene-soluble resinols was obtained by comparative distillations of four tars.

* * *

The Cause of Cancer.—David Brownlie has, in his recent book, described a new theory of the primary cause of cancer and any discovery of the cause of cancer would unquestionably be one of the greatest contributions to the happiness of mankind. Any new thesis with scientific basis must demand the most careful investigation. Mr. Brownlie, a highly experienced fuel technologist and organic chemist, has during many years of consideration formed the opinion that the primary cause of cancer is the action of poisonous organic products resulting from the decomposition under high temperature conditions of carbonaceous materials, especially bituminous coal—and also petroleum oil used in the manufacture of carburetted water gas.

It has long been known, particularly in connection with the briquette industry, that coal tar pitch is definitely cancer-causing; and in research work the more usual method is to give cancer to mice by painting them with coal tar.

According to this new theory traces of these cancer poisons are present not only in coal tar and its fractions, but also in most towns gas, as delivered to the consumer. Another primary course of cancer is the eating of smoked food such as meat and fish that has been suspended for a long time in smoke from a fire, generally wood. It will be appreciated that this is a provocative book, but the author presents much evidence in support of his theory which calls for immediate investigation. He gives in this volume, a clear description of the many problems connected with cancer which will prove of vital importance not only to the medical profession, but also to industrialists and the general public.

* * *

International Institute of Agriculture.—The Permanent Committee at its ordinary session held in March, with Dr. J. J. L. van Rijn, delegate of the Netherlands and of the Netherlands Indies and Vice-President of the Institute, in the chair, unanimously elected Baron Giacomo Acerbo, delegate of Italy, the retiring Chariman of the Permanent Committee, as Chairman for a further period of three years.

* * *

International Forestry Centre in Berlin.—The Permanent Committee of the International Institute of Agriculture, in its session of March 1938, resolved to set up an International Forestry Centre in Berlin and, according to the terms of the constitution adopted at the same session, affiliated to the International Institute of Agriculture.

* * *

The Entomological Society of India.—At a meeting of the Society, held in New Delhi, on May 18, a resolution was passed placing on record the members' deep sense of loss and sorrow at the death of Mr. Edward Meyrick, F.R.S., a recognised authority on microlepidoptera who had ungrudgingly identified microlepidopterous insects sent from India during the last 31 years.

* * *

Indian Physical Society.—At the ordinary meeting of the Society held on Saturday, 30th April, in the Physics Seminar, University College of Science, Calcutta, with Prof. D. M. Bose in the chair, the following were elected Fellows of the Society:—(1) Dr. C. W. B. Normand, (2) Dr. N. Ahmad, (3) Dr. H. J. Taylor, (4) Dr. B. C. Mukherji, (5) Dr. Swami Jnanananda . (6) Mr. Kartick Chandra Mookherji, (7) Mr. Asoke Kumar Bose, (8) Mr. Mriganka Sekhar Sinha, (9) Mr. Haripada Sen.

* * *

Discovery comes to Cambridge.—It will be remembered that this excellent popular journal of scientific knowledge was originally founded just after the War, for the purpose of disseminating the results of scientific investigations among the interested lay men. The original Trustees, Sir J. J. Thompson, Sir Frederic Kenyon, Sir Albert Seward and the late Professor R. S. Conway were men who had not only built up great bodies of scientific knowledge but have been the foremost leaders of scientific thought. They felt it their duty to help others to share in the pleasure of understanding the great advances and achievements of science.

Now the Trustees have made over their responsibilities of conducting the journal to the Syndics of the Cambridge University Press. We have no doubt that under the new auspices the journal will receive a fresh impetus and enrich the original principles and purpose for which it was founded. This journal embraces practically all fields of

scientific knowledge, and in its power of popular representation it occupies a foremost place in the ranks of popular scientific journals.

* * *

Dr. T. S. Wheeler, D.Sc., Ph.D., F.Inst.P., F.I.B., F.N.I., M.I.Chem.E.—We have pleasure in offering our congratulations to Dr. T. S. Wheeler, Principal of the Royal Institute of Science, Bombay, on whom the Senate of the National University of Ireland have conferred the degree of D.Sc. Dr. Wheeler's Scientific work has secured for him a distinguished place in the world of science. His charming manners and lovable personality have won for him a large body of admiring friends.

* * *

Mr. K. Ramayya, M.Sc., has received M.B.E. in the King's Birth Day honours and his numerous friends will rejoice at the decoration conferred upon him. His work as a Botanist in the Agricultural College, Coimbatore, has been an impressive record and we felicitate Mr. Ramayya on the appreciation of the Government of India of his contributions to science. He has been selected to act as Director of the Institute of Plant Industry, Indore, where his knowledge and experience which he has gathered as Paddy Expert, will be of great benefit in enlarging its activities.

* * *

The British Association.—We understand that at the invitation of the British Association, the Indian Science Congress has deputed Rao Bahadur T. S. Venkataraman, C.I.E., Dr. B. C. Guha and Mr. W. D. West to attend the forthcoming session at Cambridge as representatives of India. We hope that the visit of scientists from Great Britian lately begun, will become an annual practice from which much good may be expected to result.

* * *

Andhra University: Degree Course in Pharmaceutics.—Complete provision has now been made for the training of Pharmaceutical Chemists on the most modern lines. The analytical and manufacturing laboratories are quite well equipped to give the students a comprehensive course.

For analytical work and carrying out preparations on a small scale a commodious laboratory is located in the Chemistry Department and is completely equipped. It is provided with a muffle furnace, steam baths and drying ovens and separate space is set apart for the recovery of solvents. An adjacent laboratory contains analytical balances, refractometers, microscopes, a tintometer, centrifuge, colorimeter, nephelometer, spectrometer and other instruments necessary for an up-to-date analytical work on foods, drugs and water. For the teaching of Pharmacognosy there is a good botanical laboratory with a museum of drugs and a collection of plates and slides.

A manufacturing laboratory, designed for large-scale production, is situated in the Chemical Technology building and is provided with various machines for the grinding of crude drugs and the manufacturing of tinctures, extracts, confections, tablets and pills of various kinds, milk products, preserved fruits, tooth pastes, cosmetics, fine chemicals, etc. Many of these can be worked with the hand or with electrical power. Arrangements are being made for steam supply.

The library has a comprehensive collection of standard books dealing with the various aspects of Pharmacy and subscribes for a number of journals which bring knowledge up to date. Further it possesses a number of classical books relating to Indian Materia Medica and Pharmacy which are now out of print.

The lectures, laboratory work and the manufacturing operations will be carefully conducted by lecturers who have received special training in the particular lines. The syllabuses for the courses have been framed specially to meet the needs of Indian conditions. Before the students begin their special work in Pharmacy they would have received a sound basic training in physics, general engineering including machine drawing and workshop practice, chemistry, industrial chemistry and chemical engineering. They will therefore be capable of intelligently understanding and conducting manufacturing operations and also be fit to benefit by their training in analytical Pharmacy. Thus the graduate will be capable of taking up positions as manufacturing chemists or as analytical pharmacists.

It is well known that the pharmaceutical industry is specially suited to India owing to the wealth of raw materials available in the country and the large quantities of manufactured drugs that are being used every year. There is a serious lack of properly qualified pharmaceutical chemists in the country in charge of pharmaceutical business anyway comparable to the trained band of men who manage it in advanced countries elsewhere. The Central as well as the Provincial Governments are now alive to the urgent need for effecting control of foods and drugs sold in the country. In due time every large hospital and every municipality will surely realise the need for trained men in foods and drugs to effect economy and to control their purchases and expenditure as is being done in Europe and America. For all these purposes a large band of specially trained men is a necessity and the Drugs Enquiry Committee as early as 1931, emphasised the need for Universities to start courses in Pharmaceutical Chemistry and supply the necessary technical men.

The Andhra University has provided for a three-year course leading to the B.Sc. Honours degree in Technology with specialisation in Pharamceutics and subsequently a one-year course of advanced work in the subject leading to the M.Sc. degree. Students who have passed the I.Sc. with distinctions are admitted to this course which lays greater emphasis on the manufacturing side. The University has also been conducting an M.Sc. course in the Analytical Chemistry of foods, drugs and water on the same lines as the M.Sc. course of the London University. These graduates with further experience will be able to appear for the Fellowship examination of the Institute of Chemistry of Great Britian and Ireland in Branch E (Foods and Drugs). The work done during this course mainly is of a practical nature. The students analyse a large number of representative samples of foods such as milk, butter, oils and fats,

condiments, etc., water, urine and blood and receive instruction in the fundamentals of bacteriology, pharmacology, microscopy, foods and drugs laws, etc., which will enable them to interpret analytical data intelligently and draw correct conclusions.

Provision has recently been made for a number of scholarships which are available for bright students taking up these courses. There have been a large number of enquiries from students all over the country including such distant provinces as the Punjab. The courses are obviously useful to the country and hence are popular. Detailed information can be obtained from the Principal of the University Colleges, Andhra University, Waltair.

It may be mentioned here that besides Pharmaceutics, a sound course in general Chemical Technology including Chemical Engineering and the Technology of Sugar has been taught as a special subject during the past five years. With the co-operation of the sugar factories situated in the Andhra districts efficient training has been given in this branch of Technology. Now the study of Pharmaceutics has been added and very soon the Technology of Oils is also expected to be provided for. The students have, therefore, a wider choice of selecting career. The laboratories afford ample scope for advanced research work in these subjects.

* * *

University of Mysore.—*Personnel.*—Dr. M. V. Gopalaswami, B.A., B.Sc. (Lond.), Ph.D. (Lond.), Professor of Psychology and Logic, Maharaja's College, Mysore, was appointed a "University Professor" under Section 3 of the Mysore University Act, 1933.

Examinations.—The results of the Arts and Science Examinations, held in March 1938, were announced. They were as under:—

	Examination	*Examined*	*Passed*
1	Intermediate	1,175	396
2.	B.A. (New)	158	80
3.	B. A.(Old)	3	nil
4.	B.Sc.	209	123
5.	B.A. (Hons.) Preliminary	47	36
6.	B.Sc. (Hons.) Preliminary	44	41
7.	B.A. (Hons.) Final ..	29	29
8.	B.Sc. (Hons.) Final ..	21	21
9.	M.A. Qualifying Test ..	2	2
10.	M.Sc. Qualifying Test ..	2	2

Recognition.—The Royal College of Surgeons of England have recognized the Mysore Hospital (Sri Krishnarajendra Hospital) in respect of the Final Examination for the Fellowship of the Royal College of Surgeons under Paragraphs 21 and 23 of the F.R.C.S. Regulations.

General.—Mr. A. R. Gopala Iyengar, M.Sc., Lecturer in Botany, Intermediate College, Bangalore, has been awarded the Vincent Massey Scholarship for 1938–39, for the study of Applied Botany in the University of Toronto.

* * *

Announcements

The Third International Congress of Tropical Medicine, which was to have been held at Amsterdam, and the Third International Malaria Congress, which was to have been held at Madrid in 1935, had both to be postponed, but a joint Congress will be held at Amsterdam from September 24—October 1 under the Presidency of Dr. G. Gryns. Further information can be obtained from the Secretary, Mauristkade 57, Amsterdam.

The Wister Institute of Bibliographic Service.—Authors' abstracts of all papers appearing in the Wister *Journals*: *The Journal of Morphology, The Journal of Comparative Neurology, The American Journal of Anatomy, The Anatomical Record, The Journal of Experimental Zoology, American Journal of Physical Anthropology, Journal of Cellular and Comparative Physiology, The Journal of Nutrition, American Anatomical Memoirs,* are to be issued in the new Advance Abstract Card Service within 30 days of acceptance of abstract.

The present advance abstract sheet, given free for the past 14 years, will be discontinued with the June 1938 issue, to be replaced beginning in July by the new form of service. The new Card Service has been planned to meet all the needs of librarians and investigators, and is to be offered in three styles.

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From July to December, 1938—one-half annual rate.

* * *

We beg to acknowledge with thanks, receipt of the following:—

"Agricultural College Magazine, Nagpur," Vol. 12, No. 4.

"Agricultural Gazette of New South Wales," Vol. 49, No. 5.

"Journal of Agricultural Research," Vol. 56, No. 4.

"Indian Journal of Agricultural Science," Vol. 8, No. 2.

"Monthly Bulletin of Agricultural Science and Practice," Vol. 29, No. 4.

"Journal of the Royal Society of Arts," Vol. 86, Nos. 4457–61.

"Biological Reviews," Vol. 13, No. 2.

"Communications from the Boyce Thomson Institute," Vol. 9, No. 3.

"Chemical Age," Vol. 38, Nos. 982–86.

"Journal of Chemical Physics," Vol. 6, No. 5.

"Journal of the Indian Chemical Society," Vol. 15, No. 3.

"Journal de Chemie Physique," Vol. 35, No. 2.

"The Calcutta Review," Vol. 67, No. 2.

"Russian Journal of General Chemistry," Vol. 8, Nos. 3 and 4.

"Experiment Station Record," Vol. 78, No. 4.

"Transactions of the Faraday Society," Vol. 34, No. 205.

ACADEMIES AND SOCIETIES.

Indian Academy of Sciences:

May 1938. SECTION A.—K. S. K. IYENGAR AND K. V. IYENGAR: *On a Problem relating to a Tetrahedron.*—The problem of determining the tetrahedron of maximum value, the area of whose faces are given, is resolved in a more elegant way and it is further proved that in the case of n-dimensions also, there is only one orthogonal simplex, with assigned values for the $(n-1)$-dimensional volumes of its simplex-faces. S. RANGASWAMI, V. SUBBA RAO AND T. R. SESHADRI: *Reactivity of the Double Bond in Coumarins and Related α : β-Unsaturated Carbonyl Compounds—Part VI. Action of Mercuric Acetate on the Methyl Ethers of Coumarinic and Coumaric Acids.*—These acids undergo addition at the double bond as well as mercuration, whereas the 5-nitro derivatives undergo addition only. N. G. SHABDE: *The Expansion of a Function in a Series of Associated Legendre Functions.* W. M. VAIDYA: *The Flame Spectra of Some Aliphatic Halides—Part II.* (2) *Ethyl Bromide.*—Bands emitted by BrO and Br_2 have been identified. CH. I. VARADANAM: *Viscosity and Jelly Formation of Concentrated Sols of Hydrous Stannic Oxide.*—Krishnan's optical method has been employed to follow the changes in particle size in hydrous stannic oxide sol with the progress of dialysis. B. S. MADHAVA RAO: *Biquaternions in Born's Electrodynamics.* H. S. SUBBA RAO: *Eulerian Parameters and Lorentz Transformations.* K. S. K. IYENGAR: *Theorems on the Functional Limits of Derivatives of a Function at Infinity.*

May 1938. SECTION B.—C. SRIKANTIA, D. SHAMANNA AND G. S. RAGHUNATHA RAO: *Studies in Blood Sugar. I.—Vairation of Blood Sugar during Menstrual Cycle.* C. SRIKANTIA AND D. SHAMANNA: *Studies in Blood Sugar. II.—Fasting Blood Sugar of South Indian Students in Mysore.* C. SRIKANTIA AND D. SHAMANNA: *Studies in Blood Sugar. III.—Blood Sugar of Children.* R. S. CHOPRA: *Notes on Indian Hepatics. I.—South India.* R. GOPALA AIYAR AND (MISS) K. P. NALINI: *Observations on the Reproductive System, Egg-Case, Embryos and Breeding Habits of* Chiloscyllium griseum *Mull. and Henle.*—The authors have given for the first time a clear and connected account of the life history of this interesting Elasmobranch Fish from the Indian coast. The description includes a complete account of the reproductive system and the egg-case with numerous photographic illustrations of the different stages of the embryos. M. K. SUBRAMANIAM: *On* Myzostoma gopalai *Species Nova from the Madras Harbour.*

National Academy of Sciences:

(*Proceedings*, Vol. VII, Part 4.)

December, 1937.—S. K. CHAKRABERTTY AND P. B. GANGULY: *On an Equation for the Viscosity of Mixtures.* A. B. SEN: *Action of Para-Toluene Sulphonyl Chloride on Phenols containing Azo-Groups.* K. B. MATHUR: *Ionisation of F-Region before Sunrise.*

Indian Physical Society:

April 30, 1938.—K. BANERJI AND A. HAQUE: *Structure of Aromatic Compounds, Part III—Benzophenone.* K. BANERJI AND A. HAQUE: *Space Group of Creatinine.* D. M. BOSE AND P. C. MUKHERJI: *On the Origin of Colour of Paramagnetic Ions in Solution.* S. C. SIRKAR AND J. GUPTA: *On the Heat Capacity of a Few Crystals at Low Temperature.* R. C. MAJUMDAR: *On the Total Reflection of Radiowaves in Ionosphere.*

Indian Chemical Society:

March 1938.—K. GANAPATI: *Synthesis in the Alloxazine,* iso-*Alloxazine (Flavin) and Lumazin Groups—Part III. Synthesis of Some Acid Derivatives.* S. K. MITRA: *Theoketonic Esters. Part VI.* K. P. BASU AND M. C. NATH: *Organic Acid—Fe" Complex as a Disturbing Factor in the Titrimetric Estimation of Ascorbic Acid.* DUHKHAHARAN CHAKRAVARTI AND BROJESWAR MAJUMDAR: *Synthesis of Coumarins from o-Hydroxy-arylalkyl Ketones Part I.* PRAFULLA KUMAR BOSE AND RAJENDRALAL NATH: *Natural Flavones.—Part I. The Constitution of Gardenin.* L. D. SHAH: *Mercuration of Acetyl Urethane and its Substituted Amides.* AFTAB AHMAD, KARTAR S. NARANG AND JNAENDRA NATH RAY: *Synthesis of Quinozolines (and Benzoglyoxalines)—Part V.* U. P. BASU AND S. J. DAS-GUPTA: *Acridine Derivatives as Antimalarials—Part II.* SACHINDRA NATH ROY: *Note on the Use of Adsorption Indicator in Acidimetry and Alkalimetry.*

The Entomological Society of India:

(*New Delhi Branch.*)

May 18, 1938.—HEM SINGH PRUTHI AND H. L. BHATIA: *Life-history and Bionomics of the common Fruit Fly of the North Western Frontier Province.* TASKHIR AHMAD: *The amarantus Weevil Borer,* Lixus truncatulus *F. and its Parasites.* EXHIBITS: HEM SINGH PRUTHI: Euzophera punicella *Moore.* TASKHIR AHMAD: *Variation in Size and Colouration of the Common Blister Beetle.* K. B. LAL: *Some interesting Ants of Delhi.* L. N. NIGAM: *The Coffee Berry Borer.* H. L. BHATIA: *Some Fruit Flies of Delhi.* GHULAM-ULLAH: *Psyllids and Bagworms on* Casia fistula. TASKHIR AHMAD: *Grubs of the Red Pumpkin Beetle,* Aulacophora abdominalis. C. K. SAMUEL: *A Device for Feeding Small Insects on Restricted Areas of Experimental Plants.*

Erratum.

Vol. 6, No. 11, May 1938, page 557:—Contribution entitled "A Note on *Harmostomum* sp. from an Indian Toad," line 5, *for* "*Bufo tympanum*" *read* "*Bufo microtympanum*".

846-38.—Printed at The Bangalore Press, Bangalore City, by G. Srinivasa Rao, Superintendent, and Published by B. N. Sastri, M.Sc., A.I.C., A.I.I.Sc., for the "Current Science" Board of Editors, Indian Institute of Science, Hebbal Post, Bangalore.

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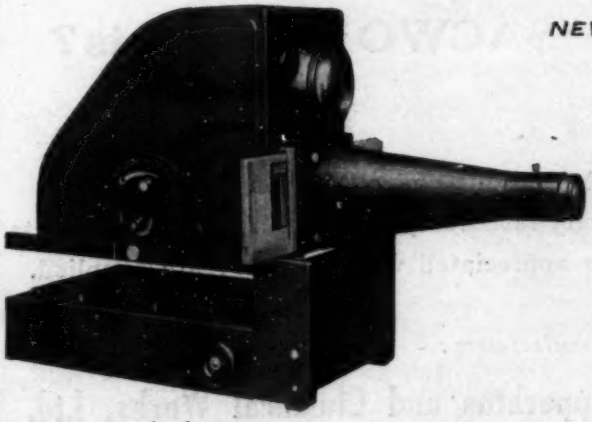

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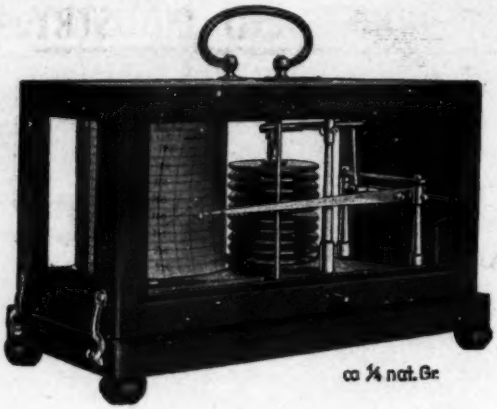

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